ROAD PAVEMENTS – BITUMINOUS BOUND MATERIALS

Contents

Contents – continued on next page

ROAD PAVEMENTS – BITUMINOUS BOUND MATERIALS

Contents Continued

901 Bituminous Pavement Mixtures

General

1 This clause gives general requirements for the properties of the aggregates and bitumen used in plant-produced bituminous mixtures. These requirements apply to all plant produced bituminous mixtures unless other requirements are given in specific Clauses in this Series.

2 Bituminous mixtures shall be produced in plants that are independently accredited to ISEN 9001 or equivalent quality management system. Products specified in accordance with IS EN 13108 shall be CE marked. All bituminous mixtures shall be laid by contractors operating in compliance with Series 700, relevant clauses of this series and BS594987.

3 Evaluation of conformity shall be carried out in accordance with the appropriate sections of IS EN 13108.

Aggregates for Bituminous Mixtures

4 Aggregates shall be natural, clean, hard and durable crushed rock or crushed gravel and shall comply with the selected requirements of IS EN 13043. Crushed gravel shall comply with category $C_{100/0}$ as defined in IS EN 13043.

Additionally, aggregates for use in surface course mixes, surface dressing, and in coated chippings for application to rolled asphalt surface courses, shall have a uniform and similar colour throughout the area of surfacing within the contract.

Where recycled coarse aggregate is used in bituminous mixtures, it shall have been tested and the content of other materials (Class X) including wood, plastic and metal shall not exceed 1% by mass. Reclaimed asphalt shall comply with Clause 902.

Resistance to Fragmentation (Hardness)

5 Irrespective of source, coarse aggregates for bituminous mixtures shall be considered suitable if:

(i) the resistance to fragmentation category of the coarse aggregate as defined in clause 4.2.2 of EN 13043 shall be LA_{30} or less;

or

(ii) crushed rock aggregate has a Los Angeles Value greater than 30 but less than 35, where evidence can be presented to the Employer's Representative of previous satisfactory use of the source in asphalt;

and the material complies with any additional requirements in Appendix 1/7

Natural and manufactured (artificial) aggregates recovered from a previous use in an unbound form shall comply with the requirements of this Clause.

Resistance to Freezing and Thawing (Durability)

6 When required in Appendix 1/5, the resistance of the coarse aggregate to freezing and thawing shall be tested. The freezing and thawing (soundness) category, as defined in IS EN 13043, clause 4.2.9.2, shall be MS_{25} unless otherwise specified in Appendix 7/1. The water absorption value of the coarse aggregate shall be determined in accordance with IS EN 13043, clause 4.2.9.1. If the water absorption value of the coarse aggregate is greater than $WA_{24}2$, the soundness test shall be carried out on the material delivered to Site. The requirements for water absorption do not apply to blast furnace slag aggregate.

Cleanness

7 The proportion of coarse and fine aggregates for bituminous mixtures passing the 0,063mm test sieve (fines content) shall not exceed the limits stated in the relevant target composition tables included within this Series, when tested in accordance with the washing and sieving method of IS EN 933-1.

Resistance to Polishing and Surface Abrasion

8 When specified in the appropriate clause or Appendix 7/1, the aggregate shall conform to the required declared PSV category in accordance with IS EN 13043 clause 4.2.3 and the relevant section of SR17.

9 An aggregate shall be deemed acceptable if the mean of the two most recent consecutive PSV results from tests relating to the aggregate to be supplied complies with the declared categories specified in Appendix 7/1. The tests must be carried out within the previous 12 months by testing by an appropriate INAB or equivalent accredited organisation.

10 The resistance to surface abrasion of coarse aggregate used in surface courses in accordance with IS EN 13043 clause 4.2.4, and the relevant section of SR17 shall conform to category AAV_{10} or such other category as specified in the appropriate clause.

Chemical Requirements
Dicalcium Silicate Disintegration

11 Air-cooled blast furnace slag aggregates shall be free from iron dicalcium silicate disintegration as defined in IS EN 13043, clause 4.3.4.1.

Iron Disintegration

12 Air-cooled blast furnace slag aggregates shall be free from iron disintegration as defined in IS EN 13043, clause 4.3.4.2.

Volume Stability

13 The volume stability category of steel slag aggregates as defined in IS EN 13043, clause 4.3.4.3 shall not exceed V_{10}.

Bitumen

14 Paving grade bitumen shall comply with IS EN 12591 and/or IS EN 13924 as appropriate and supplied from locations that are independently accredited to ISO 9001 or equivalent quality management system with specific reference to the requirements of IS EN 13108-21.

15 Polymer modified bitumen shall comply with IS EN 14023 and shall only be used where specifically permitted within this 900 series and be supplied from locations that are independently accredited to ISO 9001 or equivalent quality management system with specific reference to the requirements of IS EN 13108-21.

902 Reclaimed Asphalt

1 Reclaimed bituminous materials may be used in the production of bituminous base and binder course, subject to the requirements of IS EN 13108-8 for foreign matter category F_5. The maximum amount of reclaimed bituminous material permitted shall be 50% for Asphalt Concrete base and/or binder course.

2 After mixing with recycled materials, the binder reclaimed from the mixture shall have a recovered penetration value not less than the value specified in table 9/1. The binder shall be reclaimed from the mixture in accordance with the requirements of IS EN 12697 part 3 and tested in accordance with the requirements of IS EN 1426. Samples of the final plant mixed material must be taken at a frequency of once per thousand tonnes or a minimum of one per day.

Table 9/1

Specified Grade of Binder to IS EN 12591 (Paving Grade)	Minimum recovered penetration value of binder after mixing
40/60	30
70/100	40-60
160/220	80-120

3 When reclaimed bituminous materials are to be used in the mixture, the recovered penetration value of the binder in the reclaimed bituminous materials before mixing shall exceed 15 pen, after recovery of binder in accordance with the requirements of IS EN 12697 part 3 and testing in accordance with the requirements of IS EN 1426.

4 Where reclaimed asphalt is to be used in asphalt concrete mixtures the following requirements shall apply. All reclaimed bituminous materials shall be pre-treated before use such that the material is homogeneously mixed and the maximum particle size of reclaimed material does not exceed the upper size of the mixture or 0/32 whichever is the lesser. All reclaimed asphalt shall be classified in accordance with IS EN 13108-8. It is recommended that reclaimed asphalt comply with the following categories: Foreign matter – Category F_5.

The IS EN 13108-8 Category F_5 can be used to define the reclaimed asphalt at any stage between the raw planed or excavated material and a fully processed feedstock for a mixing plant.

In cases where reclaimed asphalt is added to the mixture, it is necessary to confirm that the properties of the total binder in the mixture, calculated from the combination of the properties of the fresh binder and the properties determined on the recovered binder from the reclaimed asphalt, conform to the grade specification for the mixture. IS EN 13108 gives the option of carrying out this calculation on either penetration or softening point. It is recommended that the penetration method is adopted in Ireland.

For all additions of reclaimed mixture, the penetration of the recovered binder from the reclaimed material shall be no less than 15 mm at 25°C, i.e. Category P15.

4 The use of reclaimed asphalt in surface courses shall not be allowed.

903 Placing and Compaction of Bituminous Mixtures

General

1 This clause gives general requirements for placing and compaction of bituminous mixtures, which are complementary and additional to the requirements of BS 594987 and the Series 700. These requirements and the requirements of BS 594987 apply to all bituminous mixtures, unless otherwise specified in the other Clauses in this Series. Where there is conflict between this Clause, or other Clauses in this Series, and BS594987, this Clause, or other Clauses in this Series, shall take precedence over BS594987.

2 Bituminous pavements shall be constructed using the materials specified in Appendix 7/1.

3 In order to exclude moisture from interfaces and ensure full interlayer bonding, the surface of all bituminous material shall be kept clean and uncontaminated. Unless agreed with the Employer, the only traffic permitted to run on the surface of bituminous material to be overlaid shall be that engaged in laying and compacting the next course or, where a binder course is to be blinded or surface dressed, that is engaged on such surface treatment. If any surface becomes contaminated, it shall be made good by cleaning and, if this proves impracticable, by rectification in compliance with Series 700.

4 Prior to placing bituminous material on any new or existing bound substrate, a bond coat or tack coat shall be applied in accordance with Clauses 920 or 942, as appropriate.

5 Before work commences, the Contractor shall submit a method statement to the Employer's Representative that includes:

(i) Laying and compaction procedures for each layer – including paving speed and paved width; size, type and number of rollers; and number of roller passes.

(ii) The joint formation procedures for each layer – including the location of longitudinal and transverse joints; and the method(s) of treating upstanding edges.

Temperature of the Mixture

6 When using paving grade binder, the maximum temperatures of the mixture, measured according to IS EN 12697-13, shall be within the general limits contained in Table 9/2 and the overriding limits contained in sub-clauses 937.17, 938.11 and 942.15 for specific mixtures and modified binders. The maximum temperature applies at any place in the plant. The minimum temperatures given here are for guidance only.

7 The minimum temperature at delivery (i.e. discharge into the truck at the plant) shall be declared by the manufacturer within the type test report. Suitable minimum temperatures at delivery to site and for compaction shall be in accordance with BS 594987.

Transporting

8 Hot bituminous mixtures shall be transported in accordance with the requirements of BS 594987 and shall remain covered whilst awaiting tipping.

Table 9/2 — Temperature limits of the mixture

Paving grade of binder	Temperature °C	
	Recommended minimum discharge at plant	Maximum
10/20, 15/25	160	200
40/60	150	190
70/100	140	180
160/220	130	170
Modified Binders	See NOTE 1	See NOTE 1

Notes:

1 When using modified bitumen or additives, different temperatures may be applicable and advice should be sought on the mixing & handling temperatures from the binder manufacturer. These temperatures shall be documented and declared as part of the type testing report.

2 Producers should note that care should be taken to avoid damage to the mixture properties arising from excessive or prolonged heating.

Layer Thickness

9 Nominal and minimum compacted layer thicknesses for asphalt concrete, hot rolled asphalt and stone mastic asphalt mixtures shall be in accordance with the relevant tables in BS. 594987 unless otherwise specified in Appendix 7/1.

Laying

10 Hot bituminous mixtures, other than those specified under Clause 938 and 942, shall be laid in accordance with the requirements of BS 594987 and sub-Clauses 10 to 16 of this Clause. Surfacings specified under Clause 938 and 942 shall be laid in accordance with the requirements of that Clause and sub-Clauses 10 to 16 of this Clause. Hot bituminous mixtures shall only be laid in weather conditions complying with Clause 945.

11 Wherever practicable, hot bituminous mixtures shall be spread, levelled and tamped by a self-propelled paving machine. The rate of delivery of material to the paver shall be regulated to enable the paver to operate continuously.

12 Hand placing of hot bituminous mixtures shall be restricted to the following circumstances:

(i) For laying regulating courses of irregular shape and varying thickness.
(ii) In confined spaces where it is impracticable for a paver to operate.
(iii) For footways.
(iv) At the approaches to expansion joints at bridges, viaducts or other structures.
(v) For laying mastic asphalt.

13 Hand-raking of surface course material or the addition of such material by hand spreading to the paved area, for adjustment of level, shall be restricted to the following circumstances:

(i) At the edges of the layers of material and at gullies, manholes and other ironwork.
(ii) At the approaches to expansion joints at bridges, viaducts or other structures.
(iii) In confined spaces where it is impracticable for a paver to operate.

14 The method of laying shall be such that the finished mat is free from dragging, tearing and segregation of the material.

15 When laying mixtures from more than one source, the mixtures shall have equivalent laying and compaction characteristics so that surface evenness is not compromised.

16 When paving adjacent to an expansion joint of a structure, the joint or joint cavity shall be kept clear of material. When laying binder course or surface course, the paver shall be taken out of use whilst laying the remainder of the pavement up to the joint and the corresponding area beyond it.

17 When paving directly onto bridge deck waterproofing systems, any special requirements which apply to that system shall be complied with.

Compaction

18 The compaction and compaction control of hot bituminous mixtures shall be in accordance with BS 594987 and the requirements for specific mixtures in:

(i) Clause 906 for Dense Base and Binder Course Asphalt Concrete (Recipe Mixtures)
(ii) Clause 929 for Dense Base and Binder Course Asphalt Concrete (Design Mixtures).
(iii) Clause 930 EME2 Base and Binder Course Asphalt Concrete
(iv) Clause 937 Stone Mastic Asphalt (SMA) Binder Course and Regulating Course
(v) Clause 938 Porous Asphalt Surface Course
(vi) Clause 943 Hot Rolled Asphalt Surface Course and Binder Course (Performance-Related Design Mixtures)

Materials covered by clauses 910, 911, 912 and 916 will rely upon method specifications in accordance with BS594987 for compaction control.

19 Except where otherwise specified, rollers shall comply with the general requirements of BS 594987 except that the minimum mass of deadweight smooth wheeled rollers shall be 8 tonnes. Multi-wheeled pneumatic-tyred rollers and vibratory rollers may be used if they are capable of achieving at least the standard of compaction of an 8-tonnes deadweight roller.

20 Where compaction is to be determined in accordance with Clauses 929 and 930 the requirements to prove the performance of rollers do not apply. In such cases, the Contractor may use any plant to achieve the specified level of compaction and shall finish compaction at temperatures above the minimum specified rolling temperature.

21 Vibratory rollers shall not be used in vibrating mode on bridge decks.

22 Where core specimens are required for the determination of properties of the laid and compacted materials, they shall be cut in accordance with BS EN 12697-27, from locations to be representative of the area or material under investigation. Cores shall be extracted without the use of excessive force and without causing damage to the core. Cores shall not be taken from freshly laid asphalt until it has cooled to a temperature of 40°C or less at mid-depth of the course to be cored.

Chippings

23 The application of coated chippings to areas of surface course shall be by a mechanical spreader capable of distributing chippings to an even rate of spread. Addition of chippings by hand operation shall only be permitted in the following circumstances:

(i) In confined spaces, where it is impracticable for a chipping spreader to operate.
(ii) As a temporary expedient, when adjustments have to be made to the spreader distribution mechanism.
(iii) When hand laying of the surface course is permitted.
(iv) To correct uneven distribution of chippings.

24 Chippings shall be applied uniformly and rolled into the surface so they are effectively held and provide the initial macrotexture depth specified in Clause 921.

Joints

25 Unless agreed otherwise with both the Employer's Representative and Specialist responsible for the design, longitudinal joints in all layers shall be situated outside wheel-track zones. For the purposes of this Clause, the wheel-track zones shall be taken to be between 0,5m and 1,1m and between 2,55m and 3,15m from the centre of the nearside lane markings for each traffic lane (or, in the absence of lane markings, lane edges). All joints shall be offset at least 150mm from parallel joints in the layer beneath. Joints in the surface course shall coincide with either the lane edge or the lane marking, whichever is appropriate.

26 The faces of all cold upstanding edges, including previously laid asphalt, against which hot bituminous mixtures are to be laid to form joints shall be treated with one of the following:

(i) hot bituminous binder with a penetration of not less than 40 pen.
(ii) hot elastomeric polymer-modified bituminous binder complying with IS EN 14023 with a penetration of not less than 40 pen.
(iii) cold applied thixotropic bituminous compound of similar bitumen or polymer-modified bitumen grade.
(iv) polymer-modified adhesive bitumen strip with a minimum thickness of 2mm.

This operation shall be done so that the binder adheres to both the cold and the warm upstanding edges when the asphalt is placed.

27 Joints in regulating and binder courses that are less than 50mm thick shall be treated as specified in BS 594987 for surface courses.

28 Joints in binder courses and bases shall be compacted such that the air voids content measured from core pairs whose centres are not more than 100mm from the final joint is not greater than 2% above the maximum permitted limit for core pairs in the body of the mat. The air voids content shall be calculated in accordance with IS EN 12697-8 using the relevant bulk and maximum densities defined in Appendix B of IS EN 13108-20 for the relevant mixture type.

29 Within 24 hours of the joint being formed, a sealant shall be applied to the top surface of all base and binder course joints such that there is not less than 0,50kg/m² of residual bitumen 75mm either side of the joint. The sealant, which may contain mineral filler to IS EN 13043, shall be one of the following:

(i) hot elastomeric polymer-modified bituminous binder complying with IS EN 14023 with a penetration of not less than 40 pen.
(ii) bitumen emulsion with a cohesion by pendulum of Class 4 or above in accordance with IS EN 13808.
(iii) slurry surfacing complying with Clause 918.

30 A sealant, as specified in sub-Clause 28 of this Clause, shall be applied to the whole of any freestanding edge on the outside of the finished pavement on the high side of the camber and, when specified in Appendix 7/1, on the low side.

Regulating Course

31 Regulating course material shall be made and laid in accordance with the requirements of Clause 907.

Use of Surfaces by Traffic

32 If due to unforeseen circumstances, a base or binder course material must unavoidably be left unsurfaced over a period of time, during which construction activity is not ongoing at the site, the local authority should implement appropriate measures to ensure that drivers are adequately alerted to the unfinished nature of the surface. These measures should include:

- Appropriate signage and lining in accordance with Chapter 8 of the Traffic Signs Manual DOT,
- The use of Cautionary Speed Plates or Statutory Road Works Speed Limits as appropriate.

In addition, in such circumstances distinctive orange coloured road marking tape or paint should be used as temporary centre line and edge markings to further emphasise the unfinished nature of the road.

The measures outlined should remain in place until the final surface course is laid.

33 Construction plant used on pavements under construction shall be suitable in relation to the material, condition and thickness of the courses it traverses so that damage is not caused to the subgrade or the pavement courses already constructed. The wheels or tracks of plant moving over the various pavement courses shall be kept free from deleterious materials.

Trafficking Newly Laid Surfacing

34 The Contractor shall ensure the pavement material has adequately cooled and hardened before the road is opened to traffic. Unless otherwise agreed by the Employer's Representative, the road shall not be opened to traffic if its surface temperature exceeds 25°C unless the maximum temperature within the mat has fallen below 35°C.

904 Not Used

905 Not Used

906 Dense Base and Binder Course Asphalt Concrete (Recipe Mixtures)

1 Dense base and binder course asphalt concrete recipe mixtures shall be asphalt concrete conforming to IS EN 13108-1, the requirements specified in this Clause and Appendix 7/1. The mixture designation shall be one of the following:

(i)	AC 32 dense base	40/60 rec
(ii)	AC 32 dense base	70/100 rec
(iii)	AC 32 dense bin	40/60 rec
(iv)	AC 32 dense bin	70/100 rec
(v)	AC 20 dense bin	40/60 rec
(vi)	AC 20 dense bin	70/100 rec
(vii)	AC 32 HDM bin	40/60 rec
(viii)	AC 32 HDM base	40/60 rec
(ix)	AC 20 HDM bin	40/60 rec

2 When the mixture designation is not specified in Appendix 7/1, the mixture selected by the Contractor shall be notified to the Employer's Representative prior to its use in the Works.

Composition

3 Evaluation of conformity shall be carried out in accordance with IS EN 13108 -1 which requires specifications to be presented as a grading envelope within which the producer's declared target grading must fall. The grading specification in Table 9/3 gives single point and/or very narrow envelope gradings, which, in combination with the tolerances from IS EN 13108-21 result in overall grading envelopes similar to those previously specified in BS 4987.

4 For base and binder course mixtures, the target and/or minimum binder content is defined in Table 9/3.

5 The aggregate grading of the target composition shall fall within the envelope given in Table 9/3.

Aggregate

6 The coarse aggregate shall consist of crushed rock complying with Clause 901.4.

7 The fine aggregate shall comply with the requirements of IS EN 13043.

8 The fine aggregate shall be either a 0/2 mm or a 0/4 mm aggregate fraction and be of one of the following types:

a) crushed rock fines produced from coarse aggregate defined in IS EN 13043 or
b) sand; or
c) a mixture of a) and b).

9 If added filler is used in dense mixtures it shall consist of crushed rock, crushed slag, hydrated lime, cement (CEM I or CEM II complying with IS EN 197-1).

10 All aggregate shall be in a surface dry condition prior to mixing.

Binder

11 The binder shall be petroleum bitumen of paving grade 40/60 or 70/100 Pen complying with IS EN 12591 as described in Appendix 7/1.

Compaction Control Procedures

12 The compaction level of base and binder course macadams shall be continuously assessed using an indirect density gauge in accordance with BS 594987 Clause 9.4.2 with readings taken at 20m intervals in alternate wheel tracks. Gauge readings shall also be taken at each core location specified in sub clauses 16 and 18. Each gauge shall be individually calibrated on each mixture from each mixing plant and the calibrations shall be continually checked and updated based on correlations between gauge readings and core densities at the same locations.

13 For each location, the in situ void content shall be determined in accordance with IS EN 12697-8 using the bulk density from the gauge reading and a maximum density taken from the mixture type testing data and updated with values from testing in accordance with sub-Clause 15.

14 The average in situ void content calculated from any six consecutive indirect gauge readings shall not exceed 7%.

15 In the event of a failure to meet the requirements in sub-Clause 14, cores shall be taken at each location and void contents determined as described in sub-Clause 20 and the evaluation of the extent of any non conformity shall be based on these. In the event of dispute or discrepancy between the two methods, only results obtained from the cores will be considered for compliance purposes. If it is necessary to remove and replace any material to restore conformity this shall be in lengths not less than 15m unless otherwise agreed by the Employer.

16 For the material from each mixing plant, a pair of cores shall be taken from the wheel tracks every 1000 metres laid and the void content shall be determined in accordance with BS 594987, such that for each of the cores, the in situ void content shall be determined in accordance with IS EN 12697-8, using the bulk density in accordance with IS EN 12697-6:2003, procedure B, saturated surface dry condition and the mean maximum density from the broken down core determined in accordance with IS EN 12697-5:2002, procedure A, in water.

17 The average in situ air voids for each core pair shall not exceed V_{max7}.

18 For the material from each mixing plant a pair of cores shall be taken every 250 metres laid, centred 100mm from the final joint position at any unsupported edge and the air void shall be determined in accordance with BS 594987, such that for each of the cores, the in situ void content shall be determined in accordance with IS EN 12697-8, using the bulk density in accordance with IS EN 12697-6:2003, procedure B, saturated surface dry condition and the mean maximum density from the broken down core determined in accordance with IS EN 12697-5:2002, procedure A, in water.

19 The average in situ void content for each of these pairs shall not exceed V_{max9}.

20 In the event of non conformity with sub-Clauses 17 or 19 then density readings with indirect gauges and, if necessary, further cores shall be taken to establish the extent. In the event of dispute or discrepancy between the two methods, only results obtained from the cores will be considered for compliance purposes. If it is necessary to remove and replace any material to restore conformity, this shall be in lengths not less than 15m unless otherwise agreed by the Employer.

21 Each core extracted shall be examined for evidence of excessive voids below the depth to which the indirect density gauge penetrates. If excessive voids are observed, further cores shall be taken to determine its extent.

22 Two copies of the final indirect density test results obtained and their correlation with in situ air void contents shall be passed to the Employer's Representative within 72 hours.

907 Regulating Course

1 Regulating courses, which may consist of one or more layers of a bituminous material, shall have their finished surfaces laid to achieve the appropriate tolerances for horizontal alignments, surface levels and surface regularity for pavement layers, in accordance with Series 700. Adopted material shall be appropriate for the layer thickness as defined in BS594987.

2 Unless otherwise specified in Appendix 7/1, Stone Mastic Asphalt complying with Clause 937, Base or Binder course asphalt concrete complying with Clause 906 or Hot Rolled Asphalt complying with Clause 910, shall be used for regulating courses immediately below surface courses. Bituminous mixtures for regulating courses shall meet the requirements for the appropriate material, as specified above.

3 Where the total depth of a regulating course exceeds 100mm then the course shall be laid so that each regulating layer has a compacted thickness of between 50mm and 100mm.

908 Not Used

909 Dense Asphalt Concrete Surface Course

1 Dense Asphalt Concrete surface course shall be asphalt concrete conforming to IS EN 13108-1, the requirements specified in this Clause and Appendix 7/1. The mixture designation shall be one of the following:

(i) AC 6 Dense Surf 70/100 rec
(ii) AC 6 Dense Surf 160/220 rec

2 When the mixture designation is not specified in Appendix 7/1, the mixture selected by the Contractor shall be notified to the Employer's Representative prior to its use in the Works.

3 Evaluation of conformity shall be carried out in accordance with IS EN 13108-1.

Additives

4 Additives permitted for inclusion may include: fibres, pigments and adhesion agents. The suitability of such additives shall be demonstrated in accordance with clause 901.2 and IS EN 13108-4.

Composition

5 Evaluation of conformity shall be carried out in accordance with IS EN 13108 -1 which requires specifications to be presented as a grading envelope within which the producer's declared target grading must fall. The grading specification in Table 9/4 gives single point and/or very narrow envelope gradings, which, in combination with the tolerances from IS EN 13108-21 result in overall grading envelopes similar to those previously specified in BS 4987.

6 For surface course mixtures, the target and/or minimum binder content is defined in Table 9/4.

7 The aggregate grading of the target composition shall fall within the envelope given in Table 9/4.

Table 9/3 — Target limits for composition of AC 32 Base and Binder Course and AC 20 Binder Course recipe mixtures

	Recipe Mixtures		
Previous BS nomenclature:	**32 mm base**	**32 mm binder course**	**20 mm binder course**
New EN nomenclature:	**AC 32 DBM/HDM[a] base**	**AC 32 DBM/HDM[a] bin**	**AC 20 DBM/ HDM[a] bin**
Test sieve aperture size (mm)	**% by mass Passing**	**% by mass passing**	**% by mass passing**
40	100	100	-
31,5	99 – 100	99 - 100	100
20	80 – 86	80 – 86	99 – 100
14	-	-	-
10	-	-	61 – 63
6,3	52 [b,c]	52 [b,c]	47 [b,c]
2	27 – 33	27 – 33	27 – 33
0,250	11 – 15	11 – 15	11 – 15
0,063 DBM & HMB	6 [b]	6 [b]	6 [b]
0,063 HDM	9 [b]	9 [b]	9 [b]
	Binder content B_{act}		
Aggregate type	**Target**	**Target**	**Target**
Limestone	4,0	4,7	4,7
Other crushed rock	4,0	4,7	4,7
Gravel	4,5	5,0	5,0

[a] Delete as appropriate
[b] Single values are recommended to ensure consistency between the original BS 4987 mixtures and those derived from the European Standard.
[c] There is no requirement in IS EN 13108-21 to apply a conformity tolerance to an optional extra coarse or fine aggregate sieve. However, to monitor mixture consistency it may be appropriate for the producer to apply the same tolerance as that applied to the characteristic coarse or fine sieve.
NOTE For Design mixtures B_{act} is the minimum target binder content.

Table 9/4 — Target limits for composition for AC 6 Surface Course Mixtures

	Recipe Mixtures
Previous BS nomenclature:	**6 mm dense surface course**
New EN nomenclature:	**AC 6 dense surf**
Test sieve aperture size (mm)	**% by mass passing**
10	100
6,3	98 [a]
4	-
2	42 – 56
1	24 – 46
0,250	11 – 19
0,063	4 – 8
Binder content B_{act}	
Aggregate type	**Target**
Limestone	6,0
Other crushed rock	6,3
Gravel	b

[a] Single values are recommended to ensure consistency between the original BS 4987 mixtures and those derived from the European Standard.
[b] The information on the target bitumen contents required for these mixtures made with gravel is not sufficient for a single target value to be specified. The bitumen content to be used should be chosen within the range 5,4 % to 6,6 %.

Aggregate

8 The coarse aggregate shall consist of crushed rock complying with Clause 901.4.

9 The fine aggregate shall comply with the requirements of IS EN 13043

10 The fine aggregate shall be either a 0/2 mm or a 0/4 mm aggregate fraction and be of one of the following types:

a) crushed rock fines produced from coarse aggregate defined in IS EN 13043 or
b) sand; or
c) a mixture of a) and b).

11 If added filler is used in dense mixtures it shall consist of crushed rock, crushed slag, hydrated lime, cement (CEM I or CEM II complying with IS EN 197-1).

12 All aggregate shall be in a surface dry condition prior to mixing.

Binder

13 The binder shall be petroleum bitumen of paving grade 70/100 or 160/220 Pen complying with IS EN 12591 as described in Appendix 7/1.

910 Hot Rolled Asphalt Surface Course (Recipe Mixtures)

1 Hot Rolled Asphalt surface course recipe mixes shall conform to IS EN 13108-4, and the requirements specified in Appendix 7/1. The mixture designation shall be one of the following, unless a stiffer binder is required by Appendix 7/1:

i) HRA 0/2 F surf 40/60
ii) HRA 30/14 F surf 40/60
iii) HRA 35/14 F surf 40/60

2 When the mixture designation is not specified in Appendix 7/1, the mixture selected by the Contractor shall be notified to the Employer's Representative prior to its use in the Works.

3 The binder shall be petroleum bitumen of paving grade 40/60 Pen complying with IS EN 12591 as described in Appendix 7/1.

4 Evaluation of conformity shall be carried out in accordance with IS EN 13108 -4 which requires specifications to be presented as a grading envelope within which the producer's declared target grading must fall. The grading specification in Table 9/6 gives single point and/or very narrow envelope gradings, which must be used in combination with the tolerances from IS EN 13108-21 resulting in overall conformity grading envelopes.

Coarse Aggregate

5 The resistance to polishing of the coarse aggregate for chipped mixtures shall be

category PSV_{44} as defined in IS EN 13043, clause 4.2.3.

Fine Aggregate

6 The fine aggregate shall be either a 0/2 mm or a 0/4 mm aggregate fraction and be of one of the following types:
a) sand; or
b) crushed rock fines produced from coarse aggregate;
c) or a mixture of a) and b).

Added Filler

7 Added filler shall consist of crushed rock, crushed slag, hydrated lime, cement (CEM I or CEM II complying with IS EN 197-1) or other material approved by both the Employer's Representative and the Specialist responsible for the design.

8 The loose bulk density in kerosene of added filler, with the exception of hydrated lime, shall be in accordance with clause 5.5.5 of IS EN 13043.

Additives

9 Additives permitted for inclusion may include: fibres, pigments and adhesion agents. The suitability of such additives shall be demonstrated in accordance with clause 901.2 and IS EN 13108-4.

Composition

10 For surface course mixtures, the target and/or minimum binder content is defined in Table 9/5. The binder content shall be: schedule 1A or 1B for crushed rock mixtures; schedule 2A or 2B for gravel mixtures.

11 The aggregate grading of the target composition shall fall within the envelope given in Table 9/6.

Coated Chippings

12 When required, coated chippings shall be 14/20mm and comply with Clause 915.

Table 9/5 —Type F Recipe Mixtures – Target Binder Content Bact

	0/2F	30/14F	35/14F
Schedule 1A	10,2	7,7	7,4
Schedule 1B	10,8	8,2	7,8
Schedule 2A	10,2	7,4	7,0
Schedule 2B	10,8	8,0	7,4

Table 9/6 —Target Composition Limits for Type F Recipe Mixtures –Target Aggregate Gradings

D	0/2F	30/14F	35/14F
Sieve	Passing sieve % by mass		
20	-	100	100
14	-	93-100	95-100
10	-	67-83	62-81
6,3	100	-	-
2	98-100	65	61
0,5	80-90	49-68	44-63
0,25	40-65	19-51	16-46
0,063	14,0	9,0	8,0

Notes:

1 For additional grading requirements, for maximum percentage of aggregate passing 2 mm and retained on 0.5 mm sieves in surface course mixtures, refer to Table 5, IS EN 13108-4.

2 In practice, the maximum passing the 0.5 mm sieve will be restricted by the value passing the 2 mm sieve.

911 Hot Rolled Asphalt Surface Course (Design Mixtures)

1 Hot Rolled Asphalt surface course design mixes shall conform to IS EN 13108-4 and the requirements specified in Appendix 7/1. The mixture designation shall be one of the following:

i)	HRA 35/14 F surf	40/60 des
ii)	HRA 30/14 F surf	40/60 des
iii)	HRA 30/14 C surf	40/60 des
iv)	HRA 35/14 C surf	40/60 des

2 The grade of bitumen required shall be 40/60 conforming to IS EN 12591 unless a stiffer binder is required by Appendix 7/1.

3 When the mixture designation is not specified in Appendix 7/1, the mixture selected by the Contractor shall be notified to the Employer's Representative prior to its use in the Works.

4 Evaluation of conformity shall be carried out in accordance with IS EN 13108-4.

Layer Thickness

5 The nominal thickness of the Hot Rolled Asphalt surface course layer shall be in accordance with the relevant table of BS594987 unless otherwise specified in Appendix 7/1.

Coarse Aggregate

6 The resistance to polishing of the coarse aggregate for chipped mixtures shall be category PSV_{44} as defined in IS EN 13043, clause 4.2.3.

Fine Aggregate

7 The fine aggregate shall be either a 0/2 mm or a 0/4 mm aggregate fraction and be of one of the following types:

a) sand; or
b) crushed rock fines produced from coarse aggregate;
c) or a mixture of a) and b).

Added Filler

8 Added filler shall consist of crushed rock, crushed slag, hydrated lime, cement (CEM I or CEM II complying with IS EN 197-1) or other material approved by the Employer's Representative and the Specialist responsible for the design.

Additives

9 Additives permitted for inclusion may include: fibres, pigments and adhesion agents. The suitability of such additives shall be demonstrated in accordance with clause 5.2.5 of IS EN 13108-4.

10 The loose bulk density in kerosene of added filler, with the exception of hydrated lime, shall be in accordance with clause 5.5.5 of IS EN 13043.

Composition

11 For Type F Design surface course mixtures, the target and/or minimum binder content shall not be less than either the appropriate minimum value from Table 9/7 and/or the design binder content determined in accordance with the protocol described in Annex H, BS 594987.

12 For Type F Design surface course mixtures, the aggregate grading of the target composition shall fall within the envelope given in Table 9/7

13 For Type C Design surface course mixtures, the target and/or minimum binder content shall not be less than either the appropriate minimum value from Table 9/8 or the design binder content determined in accordance with the protocol described in Annex H, BS 594987.

14 For Type C Design surface course mixtures, the aggregate grading of the target composition shall fall within the envelope given in Table 9/8.

Coated Chippings

15 When required, coated chippings shall be 14/20mm. Coated chippings shall also comply with Clause 915.

Table 9/7 — Limits for Target Composition for Type F Mixtures – Design Target Aggregate Gradings

D	30/14F	35/14F
Sieve	Passing sieve % by mass	
20	100	100
14	93-100	95-100
10	67-83	62-81
6,3	-	-
2	65	61
0,5	49-68	44-63
0,25	19-51	16-46
0,063	9,0	8,0
Minimum target binder content B_{act}	6,5	6,4

Note:
1 For additional grading requirements, for maximum percentage of aggregate passing 2 mm and retained on 0,5 mm sieves in surface course mixtures, refer to Table 5, IS EN 13108-4.
2 In practice, the maximum passing the 0,5mm sieve will be restricted by the value passing the 2mm sieve.

Table 9/8 — Type C Design Mixtures - Target Aggregate Gradings and Binder Content

D	30/14C	35/14C
Sieve	Passing sieve % by mass	
20	100	100
14	93-100	95-100
10	67-83	62-81
6,3	-	-
2	66	59
0,5	29-41	24-41
0,25	19-36	16-26
0,063	9,0	8,0
Minimum target binder content B_{act}	6,5	6,4

912 Close Graded Asphalt Concrete Surface Course

1 Close graded Asphalt Concrete surface course shall comply with this Clause, and the requirements specified in Appendix 7/1. The mixture designation shall be one of the following:

i) AC 10 Close Surf 160/220 rec
ii) AC 14 Close Surf 70/100 rec
iii) AC 14 Close Surf 160/220 rec
iv) AC 10 Close Surf 70/100 rec

2 When the mixture designation is not specified in Appendix 7/1, the mixture selected by the Contractor shall be notified to the Employer's Representative prior to its use in the Works.

3 Evaluation of conformity shall be carried out in accordance with IS EN 13108-

Table 9/9 — Target limits for composition for AC 14 and AC 10 Close Graded Surface Course recipe mixtures

Previous BS nomenclature: New EN nomenclature:	Recipe Mixtures	
	14 mm close graded surface course AC 14 close surf	10 mm close graded surface course AC 10 close surf
Test sieve aperture size (mm)	% by mass passing	% by mass passing
20	100	-
14	100 [a]	100
10	77 – 83	100 [a]
6,3	52 – 58	62 – 68
2	25 – 31	25 – 31
1	14 – 26	14 – 26
0,063	6 [a]	6 [a]
	Binder content B_{act}	
Aggregate type	Target	Target
Limestone	4,9	5,2
Other crushed rock	5,1	5,3
Gravel	b	b

[a] Single values are recommended to ensure consistency between the original BS 4987 mixtures and those derived from the European Standard.
[b] The information on the target bitumen contents required for these mixtures made with gravel is not sufficient for a single target value to be specified. The bitumen content to be used should be chosen within the range 5,4 % to 6,6 %.

Composition

4 Evaluation of conformity shall be carried out in accordance with IS EN 13108 -1 which requires specifications to be presented as a grading envelope within which the producer's declared target grading must fall. The grading specification in Table 9/9 gives single point and/or very narrow envelope gradings, which, in combination with the tolerances from IS EN 13108-21 result in overall grading envelopes similar to those previously specified in BS 4987.

5 For surface course mixtures, the target and/or minimum binder content is defined in Table 9/9.

6 The aggregate grading of the target composition shall fall within the envelope given in Table 9/9.

Aggregate

7 The coarse aggregate shall consist of crushed rock complying with Clause 901.4.

8 The coarse aggregate shall have a minimum resistance to polishing of PSV $60_{declared}$ in accordance with IS EN 13043 Clause 4.2.3. In addition, the resistance to abrasion of the coarse aggregate shall have a maximum category of AAV_{10} in accordance with IS EN 13043 Clause 4.2.4.

9 The fine aggregate shall be either a 0/2 mm or a 0/4 mm aggregate fraction and be of one of the following types:
a) crushed rock fines produced from coarse aggregate defined in IS EN 13043 or
b) sand; or
c) a mixture of a) and b).

10 If added filler is used in close graded mixtures it shall consist of crushed rock, crushed slag,

hydrated lime, cement (CEM I or CEM II complying with IS EN 197-1).

11 All aggregate shall be in a surface dry condition prior to mixing.

Binder

12 The binder shall be petroleum bitumen of paving grade 70/100 or 160/220 Pen complying with IS EN 12591, as described in Appendix 7/1.

913 Not Used

914 Not Used

915 Coated Chippings for Application to Hot Rolled Asphalt Surface Course

1 The chippings and the manner of coating, when used for rolling into the surface of rolled asphalt, shall be in accordance with IS EN 13108-4, the following sub clauses and with sub-clause 901.4.

2 The resistance to polishing of the chippings shall be a minimum category $PSV60_{declared}$, in accordance with IS EN 13043 Clause 4.2.3 unless a higher PSV category is required by Appendix 7/1. In addition, the resistance to abrasion of the coarse aggregate shall have a maximum category of AAV_{10} in accordance with IS EN 13043 Clause 4.2.4. The shape of the chippings shall comply with FI_{15} as defined in IS EN 13043 Clause 4.1.6.

3 The polished stone value shall be determined in accordance with IS EN 1097-8. The aggregate shall be deemed to comply if the 2 most recent consecutive results, from tests relating to the material to be supplied, and carried out within the previous 12 months by a testing laboratory accredited to ISO 17025 (INAB) approved by the Employer's Representative, are equal to or greater than $PSV60_{declared}$.

4 Binder used to coat the chippings shall be 40/60 grade conforming to IS EN 12591. The target binder content shall be not less than 1,5 %. On analysis, the binder content shall be within the range 1,2 % to 1,8 %.

5 When tested in accordance with IS EN 12697-37, the proportion of retained sand shall be not less than 4,0 % for D ≥ 16 mm and 5,0 % for D < 16 mm. Not more than 7,5 % shall fail the visual assessment.

6 Evaluation of conformity shall be carried out in accordance with IS EN 13043 and SR17.

Table 9/10 — Compliance grading of chippings

Test sieve Mm	**% (m/m) passing test sieve**
	14/20 size
31,5	100
20	90–100
14	0–25
10	0–4
6,3	—
0,063	0–2

916 Open Graded Asphalt Concrete Surface Course

1 Open graded asphalt concrete surface course recipe mixes shall be asphalt concrete conforming to IS EN 13108-1, the requirements of this Clause and the requirements specified in Appendix 7/1. The mixture designation shall be one of the following:

i) AC 10 open Surf 160/220
ii) AC 10 open Surf 70/100
iii) AC 14 open Surf 160/220
iv) AC 14 open Surf 70/100

2 When the mixture designation is not specified in Appendix 7/1, the mixture selected by the Contractor shall be notified to the Employer's Representative prior to its use in the Works.

3 Evaluation of conformity shall be carried out in accordance with IS EN 13108-1.

Table 9/11 — Target limits for composition for AC 14 and AC 10 Open Surface Course recipe mixtures

Previous BS nomenclature: New EN nomenclature:	Recipe Mixtures	
	14 mm open graded surface course AC 14 open surf	10 mm open graded surface course AC 10 open surf
Test sieve aperture size (mm)	% by mass passing	% by mass passing
20	100	-
14	98 –100	100
10	62-68	93 – 95
6,3	32 – 38	37 – 53
2	16 – 17	16 – 17
1	-	-
0,063	5 [a]	5 [a]
	Binder content B_{act}	
Aggregate type	Target	Target
Limestone	4,6	5,1
Other crushed rock	4,8	5,3
Gravel	b	b

[a] Single values are recommended to ensure consistency between the original BS 4987 mixtures and those derived from the European Standard.
[b] The information on the target bitumen contents required for these mixtures made with gravel is not sufficient for a single target value to be specified. The bitumen content to be used should be chosen within the range 5,4 % to 6,6 %.

Composition

4 Evaluation of conformity shall be carried out in accordance with IS EN 13108 -1 which requires specifications to be presented as a grading envelope within which the producer's declared target grading must fall. The grading specification in Table 9/11 gives single point and/or very narrow envelope gradings, which, in combination with the tolerances from IS EN 13108-21 result in overall grading envelopes similar to those previously specified in BS 4987.

5 For surface course mixtures, the target and/or minimum binder content is defined in Table 9/11.

6 The aggregate grading of the target composition shall fall within the envelope given in Table 9/11.

Aggregate

7 The coarse aggregate shall consist of crushed rock complying with Clause 901.4.

8 To ensure adequate resistance to polishing and abrasion, the coarse aggregate shall have a minimum declared PSV and a maximum AAV, as specified in Appendix 7/1.

9 The fine aggregate shall be either a 0/2 mm or a 0/4 mm aggregate fraction and be of one of the following types:

a) crushed rock fines produced from coarse

aggregate defined in IS EN 13043 or
b) sand; or
c) a mixture of a) and b).

10 If added filler is used in open graded mixtures it shall consist of crushed rock, crushed slag, hydrated lime, cement (CEM I or CEM II complying with IS EN 197-1).

11 All aggregate shall be in a surface dry condition prior to mixing.

Binder

12 The binder shall be petroleum bitumen of paving grade 70/100 or 160/220 Pen complying with IS EN 12591 as described in Appendix 7/1.

917 Cold-milling (Planing) of Bituminous Bound Flexible Pavement

1 Where cold-milling of bituminous bound flexible pavement is required, the area of carriageway to be milled shall be removed to the specified depth by a suitable milling machine. The process shall be carried out so as not to produce excessive quantities of either fumes, smoke or dust. Dust shall be minimised by damping with water sprays.

2 The cut edges shall be left neat, vertical and in straight lines. The Contractor shall brush and sweep the milled surface by mechanical means to produce a clean and regular running surface with a groove depth not greater than 10 mm, and with a uniform texture.

3 Carriageways shall be milled to the tolerance for surface levels specified in Clause 702 for binder course. If the tolerances in this Clause are exceeded, the full extent of the area, which does not comply, shall be rectified by further milling or by regulating with materials in accordance with Clause 907.

4 Existing ironwork shall not be disturbed by the milling action. Where necessary, surfacing in the vicinity of ironwork and in other small or irregular areas shall be cut out by pneumatic tools or other suitable methods and removed.

5 Where milling is carried out on a carriageway open to traffic, temporary ramping to ensure the safe passage of vehicles shall be provided in accordance with the requirements of Appendix 1/17.

6 If the milled surface profile varies by more than 10 mm, when measured transversely or longitudinally by a 3 metre straight edge, adjustments or replacements shall be made to the cutting teeth on the milling drum before work continues. Any discontinuity between adjacent milling passes exceeding 10 mm, when measured transversely by a 3 metre straight edge, shall be rectified by further milling or regulating before placing bituminous materials.

7 Where milling is required over extensive areas, the Contractor shall programme the work to allow removal of full lane widths unless this is impracticable. The Contractor shall notify his proposed programme of milling to the Employer's Representative prior to commencement of the work.

8 Immediately after milling, surplus material shall be removed by a machine of suitable and efficient design and the milled surface swept to remove all dust and loose debris.

9 Where possible the material removed from the carriageway shall be reused in accordance with Clause 902 or in other such locations as approved by the Employer's Representative. All other surplus material shall be run to licensed tips identified by the contractor. No stockpiling shall be allowed on Site unless the material is to be used in the Works.

10 Carriageways, which are closed to traffic, shall be resurfaced after milling prior to reopening the carriageway to traffic, unless otherwise agreed by the Employer's Representative.

918 Slurry Sealing

1 Slurry sealing shall comply with IS EN 13808, BS 434: Part 2, Table 3 of RC380 National Roads Authority Binder specifications and with sub-Clauses 2 to 22 of this Clause.

Aggregate

2 Crushed or natural sand free from silt, clay or other fine material. The aggregate, whether a mixture or not, shall have a smooth grading within the limits of Table 9/12.

Additive

3 The additive shall be CEM1 or CEM2 Portland cement complying with IS EN 197: Part 1 or hydrated lime complying with IS EN 459-1 At least 75% shall pass the 63 micron sieve.

Table 9/12 Aggregate Grading

Sieve Size (mm)	Percentage by mass of total aggregate and additive passing	
	3mm finished thickness	1,5mm finished thickness
6,3	100	100
4	80 – 100	100
2	75 – 100	95 – 100
1	55 – 90	70 – 95
0,250	20 – 45	30 – 50
0,063	5 – 15	5 – 15

Bitumen Emulsion

4 The slurry seal bitumen emulsion shall comply with IS EN 13808 and the specific requirements of Table 3 of RC380 National Roads Authority binder specifications.

Tack Coat

5 Where required, or described in Appendix 7/3, tack coat shall be cationic bitumen emulsion complying with IS EN 13808 and the specific requirements of Table 3 of R380 National Road Authority binder specifications.

Composition of Mixed Material

6 The mixed material shall comprise aggregate, bitumen emulsion and, where necessary, additive complying with sub- Clause 3 of this Clause. The amount of emulsion used shall be between 180 litres/tonne and 250 litres/tonne of dry aggregate; the precise proportions of each constituent being selected after laboratory tests and trials using the same plant intended to be used in the Works. When additive complying with sub-clause 3 of this Clause is used, the proportion shall not normally exceed 2% by mass of aggregate.

Mixing

7 The materials shall be measured into a mechanical mixer and mixed such that the aggregate is completely and uniformly coated with bitumen emulsion and slurry is produced of consistency that can be satisfactorily laid as described in sub-Clauses 12 to 14 of this Clause. When required, an additive complying with sub-Clause 3 of this Clause, shall be used to control consistency, mix, segregation and setting rate.

Preparation of Site

8 Before applying tack coat or spreading slurry, any necessary patching of the road surface shall be completed. Immediately before application of bituminous materials, loose material, dust and vegetation shall be cleaned from the existing surface by sweeping, supplemented if necessary by air jet, and removed from the site. All ironwork, road studs and road markings, shall be masked. At junctions with surfaces not to be treated, clean lines shall be defined by masking, or other suitable means.

Laying

9 If required, a tack coat shall be applied in accordance with BS 434: Part 2 before spreading the slurry seal.

10 The rate of spread of tack coat shall depend on the surface to be treated, and shall be in accordance with Tables 1 and 2 of BS594987.

11 Slurry shall be evenly spread by mechanical means such that the aggregate cover (dry mass equivalent) is 4-6kg/m^2 for 3 mm finished thickness and 2-4kg/m^2 for 1,5 mm finished thickness.

12 All voids, cracks and surface irregularities shall be completely filled. Spreading shall not be undertaken when the ground temperature falls below 4°C or when standing water is present on the surface. In warm dry weather the surfacing, immediately ahead of the spreading, shall be slightly damped by mist water spray applied mechanically.

13 The slurry shall be rolled by a self propelled or towed multi-wheeled smooth tread rubber-tyred roller, having an individual wheel load between 0,75 and 1,5 tonnes, making at least six passes unless the Contractor demonstrates that rolling is unnecessary or that a smaller number of passes is satisfactory for a particular process. Rolling shall commence as soon as the slurry has set sufficiently to ensure rutting or excessive movement will not occur.

14 The finished slurry shall have uniform surface texture and colour throughout the work, without variations of texture within the lane width, or from lane to lane, due to segregation of aggregates or colour, due to variations in the emulsion water content of the mixture.

15 The finished surface shall be free from blowholes and surface irregularities due to scraping, scabbing, dragging, droppings, excess overlapping or badly aligned longitudinal or transverse joints, damage by rain or frost, or other defects. Slurry sealing

which does not comply with this Clause or is non-uniform in surface texture or colour 24 hours after laying shall be rectified by removal and replacement with fresh material rolled in compliance with the Specification or, if this is impractical, by having fresh material superimposed and rolled in compliance with the Specification. Areas so treated shall be not less than 5m long and not less than one lane wide. All areas being worked on shall be kept free of traffic until permitted by the Employer's Representative.

Preliminary Slurry Mixture Design and Trial Areas

16 Using the same plant proposed for the Works, the Contractor shall make trial mixes of the slurry, varying the bitumen emulsion aggregate ratio to produce a slurry of creamy consistency which, whilst the screed box is travelling at the laying speed, will flow ahead of the screeding blade across the whole width of the spreader at all times. At least three trial mixes shall be made, each sufficient to spread a trial area of 40 square metres, to the specified finished thickness. The preparation of the existing surface for the trials, the tack coat spreading and the rolling methods shall comply in all respects with this Clause. Trial areas, which achieve the required spreading consistency, will be examined after 24 hours, for surface texture and adhesion, and if satisfactory the test specified in sub-clause 17 of this Clause shall be carried out on samples of the same composition.

17 For each of the satisfactory trial mixes, at least two circular specimens shall be prepared, as described in BS 434: Part 2, for a wet track abrasion test. The approved mix proportions for the main work shall be selected following laboratory tests using a combination of bitumen emulsion, aggregate blended where necessary with additive and water, having a wet track abrasion test result of less than 500g/m^2.

18 When a proposed mix has been approved variations shall not be made in mixing time, mix proportions or in the type, size, grading or source of any of the constituents without the agreement of the Employer's Representative who may require further tests to be made.

Site Control Tests

19 The mix proportions shall be controlled and the mass of all materials incorporated shall be checked and recorded at least four times daily. The quantity of emulsion used, and the rate of spread of mixed material, in kilogram's of aggregate per square metre, shall be recorded for each load of aggregate and, if required, for each separate run within a load of aggregate.

20 The Contractor shall provide all necessary testing equipment and whenever spreading is taking place shall carry out the tests specified in Table 9/13 at the frequency stated therein. A copy of the results of each of the tests, and of each recorded mass and check for rate of spread, shall be passed to the Employer's Representative.

21 75g of the blended aggregate shall be weighed in a glass beaker or similar container and the corresponding quantities of water and cationic emulsion in the slurry mix added. The slurry shall be stirred with a slow deliberate action (about 60rpm) for 15 to 30 seconds, after which a specimen of about half the mixture shall be cast upon an impervious surface.

22 The cast specimen shall exhibit cohesive properties in not more than 10 minutes and when set and drenched in water shall be water fast as demonstrated by the absence of brown colour in the wash water.

Table 9/13 Site Control Tests

Test	Frequency	
	Batch Mixing	Continuous Mixing
Wet Track Abrasion Test (BS 434: Part 2)	4 times daily	Every second run
Grading of each separate stockpile of sand and crusher run fine aggregate	Every 20 tonnes	Every 20 tonnes
Grading of the samples of the blended aggregate	4 times daily	4 times daily
Percentage of the bitumen in cured seal	4 times daily	4 times daily

919 Surface Dressing: Recipe Specification

1 Surface dressing shall be designed and carried out in accordance with the recommendations of the Institute of Asphalt Technology (IAT) – Guidelines for Surface Dressing in Ireland, current revision, and the requirements as stated in Appendix 7/3.

Aggregates

2 The chippings shall be crushed rock or crushed gravel complying with the requirements of clause 901.4 of this series.

3 The polished stone value requirements from Table III of the IAT guidelines shall be category $PSV60_{declared}$ $PSV57_{declared}$ or $PSV52_{declared}$ as appropriate and as specified in Appendix 7/2.

Aftercare

4 Aftercare shall be carried out in accordance with section 5 of the IAT guidelines.

5 Any defects arising from deficiencies in the materials, workmanship and aftercare manifest during or at the end of the Defects Period shall be rectified by the Contractor at his own expense.

As Built Manual

6 Not more than 30 days after completion of the work the Contractor shall provide a record of the progress of the work in accordance with section 6 of the IAT Guidelines and any such other information that the Employers Representative may reasonably require to be included.

920 Bond Coats, Tack Coats and other Bituminous Sprays

1 A bond or tack coat shall be sprayed onto the existing surface prior to overlay in accordance with sub-Clauses 3 and 4. Bond or tack coats for Asphalt Concrete and Hot Rolled Asphalt shall be in accordance with BS 594987 and sub-Clause 3. Application shall be by spray tanker. For small areas application may be by hand held sprayer with the agreement of the Employer's Representative. The surface shall be prepared for the application of a bituminous spray and when undertaking spraying and any specified blinding. This shall be done in accordance with the requirements as set out in BS594987 in so far as it applies to the work to be undertaken in accordance with the under mentioned general requirements and any specified requirements as described in Appendix 7/4.

2 The bond coat, tack coat or bituminous spray shall be sprayed grade cationic bitumen emulsion complying with BS 594987, the Binder Specification and RC380 published by the National Roads Authority. Where a bond coat incorporating a polymer modified emulsion is proposed for use it shall have prior written approval from the Employer's Representative. The binder shall be sprayed at a rate as specified in BS 594987.

3 The Employer's Representative may require the Contractor to provide a test certificate showing that a particular binder distributor has been tested since the previous surface dressing season and that the test indicates conformity of the distributor with the requirements of IS EN 12272-1 for emulsion distributors.

4 Before spraying is commenced, the surface shall be free of all loose material, the surface as a whole shall be dry and any damp areas shall be completely free of standing water.

5 Blinding material, where required by the Contract, shall consist of a hard clean crushed rock, fine aggregate or sand: it shall not contain more than 15 per cent retained on a 6,3 mm sieve. It shall be applied to the binder and left unrolled. The rate of application shall be 5,5-7,0kg/m^2.

6 All loose material on the sprayed surface, including any blinding material, shall be removed before any further layer of the pavement is laid.

921 Surface Macrotexture of Bituminous Surface Courses

1 The initial surface macrotexture for bituminous surface courses after compaction and before traffic measured using the volumetric patch method described in IS EN 13036-1 and the procedures in BS 594987, clause 8.2 shall not be less than the appropriate values shown in Table 9/14.

2 For newly laid surfaces, measure the surface texture as soon as possible after the surfacing has been laid and before opening to traffic. For all carriageways i.e. Single, Dual etc, these measurements should be carried out for each individual carriageway lane width. Make measurements on 50m lane lengths regularly spaced along the section and covering not less than one-third of the section tested. On each 50m lane length, take 10 individual measurements of the texture depth at approximately 5m spacings along a diagonal line across the carriageway lane width. Do not take measurements within 300mm of the longitudinal edge of the carriageway.

To reduce the variability, base the determination of the average texture depth of a test section on not less than six sets of ten individual measurements. For small schemes it may be practicable to carry out measurements over all of the surface course or

over alternate 50m lengths covering 50 percent of the work. Where this cannot reasonably be done make the test measurements over regularly spaced 50m lengths of carriageway lane, covering not less than one-third of the surfacing laid in one lane. On larger schemes, exceeding a kilometre in length, select test sections of carriageway lane 1000m long in the same way.

3 For surface courses the surface texture may be measured using a Laser system to the specification necessary to enable the Mean Profile Depth (MPD) to be calculated at one metre intervals in accordance with ISO 13473-1-2004 e.g. RSP or equivalent.

4 Whilst measurement of macrotexture for compliance purposes is by the volumetric patch technique specified in IS EN 13036-1 only, the measurement using MPD may be used as a screening procedure. In the event of dispute or discrepancy between the two methods, only results obtained using the volumetric patch technique will be considered for compliance purposes.

922 Not Used

923 Binder Reclaimed using the Rapid Recovery Test (RRT) and Accelerated Ageing using the Modified Ageing Rolling Thin Film Oven Test (RTFOT)

Scope

1 This Clause specifies the procedure for obtaining a quantity of 'Recovered Binder' from modified or unmodified cutback or emulsion binder (Rapid Recovery Test - RRT) and an extended procedure for obtaining a quantity of 'Aged Binder' (Modified Ageing Rolling Thin Film Oven Test). 'Aged Binder' may be prepared directly from 'Recovered Binder' or from other binder samples. Binders used to manufacture hot mix asphalt are first subjected to a 'short term ageing test' (RTFOT) to simulate the effects of manufacture, transport and laying. The Modified Ageing RTFOT is suitable for all bituminous binders and rapidly provides homogeneous samples at different ages so that a plot of a relevant characteristic with ageing may be generated.

Definitions

2 For the purposes of the procedure specified in this Clause, 'Recovered Binder' shall be defined as: the material remaining after treatment of the original product under the conditions specified by the Rapid Recovery Test method (RRT). 'Aged Binder' shall be defined as: the material remaining after the Ageing protocol specified by the Modified Ageing RTFOT method.

Table 9/14: Requirements for Initial Macrotexture Depth

Road Type	Surfacing Type	Average per 1000m section, mm	Average for a set of 10 Measurements, mm
Mandatory speed of traffic > 60 km/hr	**Chipped Hot Rolled Asphalt and surface dressing:**	Not less than 1,5	Not less than 1,2
Mandatory speed of traffic ≤ 60 km/hr and roundabouts	**All surface course materials Chipped Hot Rolled Asphalt, surface dressing and asphaltic concrete.**	Not less than 1,2	Not less than 1,0

Note:
For initial macro texture depth of Polymer Modified Stone Mastic Asphalt refer to Clause 942 Table 9/37

Principle of the Rapid Recovery Test (RRT) for Bituminous Emulsions, Cutbacks or Fluxed Binders - Polymer Modified or Unmodified

3 A thin film of binder is rotated in polytetrafluoroethylene bottles using the rolling thin film oven test apparatus (RTFOT), as described in BS EN 12607-1, to evaporate water from bituminous emulsion and/or the light solvent or highly volatile fraction from cutback, fluxed or other binder. Special screws are used to disturb the binder and maintain a homogenous material during breaking and/or curing. Nitrogen gas instead of air is jetted over the film of emulsion, cutback or fluxed binder and a lower temperature is used in order to minimise ageing effects and simulate the condition of the binder soon after application (it is assumed that these binders when used are not subjected to the high temperature mixing associated with an asphalt plant where the appropriate test is the RTFOT using air at 163ºC).

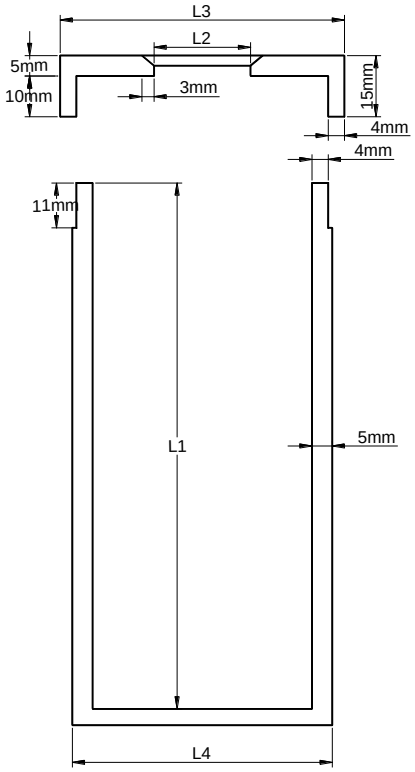
Test Apparatus

4 The following test apparatus shall be used:

(i) RTFOT apparatus to BS EN 12607-

(ii) Eight identifiable bottles manufactured from polytetrafluoroethylene (PTFE) with threaded screw top lid (or other fixing system) with internal dimensions and aperture diameter (L2) as shown below:

PTFE Bottle

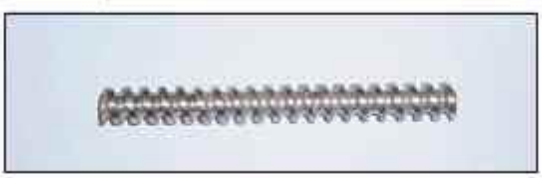


The taper in throat is 45o + 5o (11/04)

Bottle dimensions	
L1	129 ± 1,2mm
L2	31,75 ± 1,2mm
L3	70 ± 1,2mm
L4	64.0 ± 1,2mm
Note: All other dimensions are approximate. (11/04)	

(iii) Eight screws manufactured from high quality stainless steel (surgical quality) complying with BS EN 10088-3, designation 1.4404 to a 'fine machined finish'. All screws shall have dimensions: diameter 12,2 mm ± 0,2 mm and length 120 mm ± 0,5 mm and have between 20

and 21 turns with a pitch of 6 mm ± 0,2 mm. The depth of cut shall be 2 mm ± 0,2 mm with a semi-circular profile - see photograph. The minimum weight of a screw shall be 70g. The direction of screw shall be such that the binder sample is drawn to the closed end of the bottle when the bottle containing the screw is rotated in the carousel;



(iv) A spatula for removing the binder from the bottle (a flat blade or paddle shape, see photograph, has been found suitable);

(v) A balance accurate to 0,05g;
(vi) A timer capable of timing 100 minutes, accurate to 1 second in five minutes and for the Modified Ageing RTFOT a timer capable of timing 25 hours to the same accuracy;
(vi) Nitrogen gas supply and air supply;
(vii) An oven to pre-heat the bottles to the maximum storage temperature of the binder (for example 140ºC ± 5ºC for cutback surface dressing binders); and
(xi) A microwave oven of medium power to remove final traces of water from emulsion binders (650 watts has been found to be suitable).

Test Procedure for Recovery of Bituminous Emulsion, Cutback and Fluxed Binders

5 The test procedure for 'Recovery' of bituminous binders shall be as follows:

The RTFOT oven shall be set to maintain a temperature of 85°C ± 2°C and the oven temperature allowed to stabilise.

The PTFE bottles (including lids) with stainless steel screws, shall each be weighed to 0,1g and pre-heated in an oven to 85ºC ± 2ºC.

The binder sample shall be freshly decanted from the thoroughly stirred main sample, which shall have been sampled in accordance with BS EN 58. The temperature of the binder sample shall not be less than 70 % of the normal application temperature in degrees Celsius and shall be recorded (for example high binder content surface dressing emulsion may require a minimum of 60ºC or a polymer modified cutback binder 130ºC). The sample history if known shall be recorded.

Any sub-sample, which shall be not less than 250 ml, shall be thoroughly stirred to ensure homogeneity immediately prior to decanting into the bottles, taking care to minimise loss of water content and/or any volatile oil. Gentle heating may be necessary to a maximum of the normal application temperature in order to obtain a homogenous sample.

19g ± 0,5g of binder sample shall be weighed out into each pre-heated bottle with screw. The weight of each bottle with screw and binder shall be recorded to 0,1g.

Immediately after weighing the bottles with screws and binder sample they shall be rolled on the bench to ensure distribution of the binder round the bottle before mounting in the carousel of the pre-heated RTFOT apparatus.

Rotate the carousel with the nitrogen gas supply jet switched on, set up and calibrated as detailed in BS EN 12607-1. Nitrogen gas flow shall be 4,000 ± 200 ml/min.

Start the timer.

The period between weighing the bottles with binder and mounting of all the bottles and the start of the rotation of the carousel shall not exceed 20 minutes.

After 75 minutes ± 1 minute the rotating carousel shall be stopped and the time shall be noted.

Establishing the Microwave Heating Procedure for Bituminous Emulsions only (not needed if proceeding to the Modified Ageing RTFOT without sampling)

Remove two bottles with their screws and binder from the carousel, weigh them and record the weight loss to 0,1g. Remove the screw from a bottle and return as much as possible of the binder sample clinging to the screw back into the bottle. The lids may need to be removed and replaced. Re-weigh the bottles. Place the two bottles with the binder sample and any reclaimed binder sample from their respective screws in the microwave oven together with a glass beaker containing water as a heat sink (around 200 ml has been found to be suitable to prevent spitting and

overheating of the sample) and set a cycle time (two minutes has been found to be suitable in a medium power microwave). The cycle time shall be such that the temperature of the sample does not exceed 90ºC as measured at the end of each cycle. After heating, re-weigh and record the weight loss as before. The time taken to weigh the bottles after the first cycle shall be recorded as the 'rest period' and used between further cycles (generally about two minutes). Cycles shall be repeated until the recorded weight loss is within 0,05g of that of the previous cycle (generally just one or two cycles are required). Report the average percentage binder weight loss to 0,2%. Record the number of cycles and cycle time. The individual results shall be within 2,0% of the mean or the test repeated.

If the binder sample has been shown to possess a high flash point (greater than any localised temperature experienced in the test) and/or the screws are used in such a way as to minimise any risk of sparking or arcing (electrical discharge) then the screws may be left in the bottles during the microwave heating procedure.

Except where the bottles are to be subsequently used for the Modified Ageing RTFOT, remove the other six bottles from the carousel. Repeat the procedure as for the two bottles using the same rest period, but with one cycle time less. If an estimate of binder content is needed then record the weight loss to 0,1g.

The whole of this procedure shall not exceed 30 minutes. If more binder from the same main sample is to be 'Recovered' then the procedure to establish the cycle time need not be repeated unless significant changes to the binder in storage are expected (for example the water content may change).

Note: It has been found to be advantageous to place the bottles on their sides in the microwave oven. This allows the binder to drain collecting to one side of the bottle, which is more easily removed with the scraper.

The weight loss after 'Recovery' shall be recorded by weighing two bottles.

The 'Recovered Binder' shall be scraped from the bottles and screws.

Unless the 'Recovered Binder' is to be treated by the Modified Ageing RTFOT it shall be transferred, before it cools to ambient, to other test apparatus such as a Dynamic Shear Rheometer (Clause 928), in order to minimise further changes to the binder.

If the 'Recovered Binder' is to be stored or transferred to another location for testing, it shall be placed on a silicone sheet or in a warmed penetration pot (at a temperature not greater than 90ºC) and the binder surface sealed using aluminium foil or other suitable material to prevent further loss of volatiles and minimise exposure to air. 'Recovered Binder' shall be stored at a temperature of between 0ºC and 5ºC.

During transfer 'Recovered' samples shall not be subjected to temperatures greater than ambient and the delay before testing shall not exceed 120 hours.

Re-heating for testing shall be in accordance with BS 2000: Part 72 except that the 'Recovered Binder' shall not be heated above 90 ºC unless absolutely necessary for the test. The thermal history shall be recorded.

Modified Ageing Rolling Thin Film Oven Test (RTFOT)

Principle of the Modified Ageing RTFOT

6 A thin film of binder is rotated in bottles using the rolling thin film oven test apparatus, as described in BS EN 12607-1. Special screws are used to disturb the binder and maintain a homogenous material during 'Ageing'. Air is jetted over the film of binder for a much longer period than in the conventional test and a lower temperature used in order to simulate the 'ageing' of the binder in the road after application. The binder tested may be 'Recovered Binder', or Binder after RTFOT, either using the procedure detailed in this Clause or BS EN 12607-1, or other binder sample.

The Modified Ageing RTFOT shall be carried out as follows:

(i) Bituminous Emulsion, Cutback and Fluxed Binders Stabilising

The bottles, with screws remaining, containing the samples after the Rapid Recovery Test, shall be treated in the Modified Ageing RTFOT maintaining a temperature of (135ºC ± 2ºC) with the same nitrogen gas supply at 4000 ± 200 ml/min. After 1 hour ± 5mins two bottles shall be removed and shall be weighed to 0,1g. If the weight loss is less than 2,0% of the 'Recovered Binder' then the ageing protocol shall commence by switching to an air supply at 4000 ± 200 ml/min. If not then the bottles shall be placed back in the carousel with the nitrogen supply maintained and the weight loss recorded for these two bottles after each hour until

the weight loss has stabilised to less than 2,0% of the previous binder weight.

If the same binder from the same main sample is to be 'Stabilised' after 'Recovery' then the procedure to establish the stabilising time need not be repeated unless there are expected significant changes to the binder sample in storage.

Ageing

The samples shall be rotated in the air supply and two bottles removed if required for testing after three periods: 3hrs ± 10mins; 8hrs ± 10mins; and 22hrs ± 10mins.

The bottles and screws shall be scraped to transfer the binder samples to the appropriate test equipment or, if required to be used later, placed on a silicone sheet, or in a penetration pot, and sealed and stored at between 0ºC to 5ºC.

'Aged Binder' is deemed to be the sample from the 8 hr period.

The combined test may be run continuously without interruption from the beginning of the Rapid Recovery Test, except for change in temperature and changeover from nitrogen gas to air supply and any 'Recovered Binder' samples removed for testing.

For the continuous treatment of samples (combined test) there is no need for the microwave procedure to be used.

(ii) Binders for Manufacturing Asphalt or other Hot Mixed Materials.

The initial conditioning test is to simulate the changes to the properties of the binder caused by the high temperatures during manufacture, transport and laying. The screws accelerate the process, and are necessary to maintain a homogeneous material especially when testing polymer modified binders, which tend to form a skin and separate into phases.

The standard 'short term ageing test' RTFOT shall be carried out in accordance with BS EN 12607-1, at the same test temperature of 163ºC but with the following exceptions: a test time of 45 minutes ± 1 minute; PTFE bottles with screws inserted shall replace the glass bottles; 19g ± 0,5g of binder shall be weighed out into each preheated bottle; weighing of bottles to determine weight loss shall be carried out within 2 minutes of removal from the carousel without the need to be placed in a desiccator; and bottles and screws shall be scraped to remove the 'short term aged binder'.

The RTFOT treated binder shall be tested for weight change by removing two of the bottles and weighing within 2 minutes ± 1 minute. If required for testing the 'short term aged binder' shall be removed by scraping and transferred to the appropriate test equipment or, if required to be used later, placed on a silicone sheet, or in a heated penetration pot (maximum 170ºC), and sealed and stored at between 0ºC to 5ºC.

The remaining samples shall then be subjected to the Modified Aging RTFOT.

The temperature is reduced/set to (135 ºC ± 2ºC) and the Modified Ageing RTFOT carried out:

The air supply shall be set at 4000 ± 200ml/min.

Start the timer.

The samples shall be rotated in the air supply and two bottles removed if required for testing after three periods: 4hrs ± 10mins; 8hrs ± 10mins; and 22hrs ± 10mins.

Note: It has been found to be advantageous to place the bottles on their sides. This allows the binder to drain to one side of the bottle, which is more easily removed with the scraper.

The bottles and screws shall be scraped to transfer the binder to the appropriate test equipment or, if required to be used later, placed on a silicone sheet, or in a heated penetration pot (maximum 170ºC), and sealed and stored at between 0ºC to 5ºC.

'Aged Binder' is deemed to be the sample from the 8 hr period.

The combined test may be run continuously without interruption from the beginning, except for the reduction in temperature after 45mins from 163ºC to 135ºC and at that time removal of bottles for test after RTFOT if required.

During transfer 'Aged' samples shall not be subjected to temperatures greater than ambient and the delay before testing shall not exceed 120 hours.

Re-heating for testing shall be in accordance with BS 2000-72 except that the 'Aged Binder' shall not be heated above 140ºC unless absolutely necessary for the test. The thermal history of the sample shall be recorded.

924 High Friction Surfacing

1 High Friction Surfacing shall be produced and manufactured by a company independently accredited to ISO 9001 or equivalent quality management system. High skid resistant surface treatments, made with aggregate of high polishing resistance and resin-based binders, shall consist of a film of binder sprayed on to a sound substrate and covered with aggregate to provide a textured, durable matrix of high skid resistance.

Binder

2 The binder shall contain an epoxy or other approved resin component.

Aggregate

3 The aggregate shall be calcined bauxite which has, when determined in accordance with IS EN 1097-8, a minimum polished stone value of $PSV72_{declared}$. The grading of the aggregate shall be such that not more than 5% is retained on a 4mm sieve and not more than 5% passes a 1mm sieve. The aggregate shall be clean and free from foreign matter.

4 At least one month before surfacing is to take place the Contractor shall submit to the Employers Representative full details of the constituent materials of the mixture, all test results and the mixing and laying proposals including mix temperatures both at production and delivery to the site.

Mixing of Binder and Accuracy of Spraying

5 The binder shall be sprayed by a metered machine that accurately and continuously batches together the components of the binder; intimately mixing them before spraying. A control mechanism shall maintain each component within 5% by mass of the normal proportion specified by the resin manufacturer and a calibrated flow meter (or other approved means) shall be provided for each component. If the components of the binder are heated to facilitate spraying, the temperature shall not exceed the maximum recommended by the resin manufacturer. A temperature gauge accurate to ± 2°C shall be used with all binders that require heating.

6 The vessels containing the components shall each be provided with an approved method of measuring the volume of material used.

7 The machine shall spray the binder, such that the amount collected on any longitudinal stretch of the surface 50mm wide within the width of the spray shall not be less than 90% of the overall minimum requirement for the surface being treated (see sub-clause 8 of this Clause). The mean amount of binder collected on any four adjacent 50mm wide strips shall be not less than 95% of the overall minimum requirement. Before work commences, and thereafter at intervals not exceeding one month, the Contractor shall provide evidence that the sprayer and all metering gauges complies with the requirements of the Specification. The test to measure the spray pattern shall be carried out in the presence of the Employer's Representative unless the Employer's Representative declines to attend.

Preparation

8 The surface shall be vigorously brushed to remove dust, laitance and other loose matter. Any oil visible on the surface shall be removed by washing and scrubbing with a detergent solution followed by flushing with clean water or by another approved method. The surface shall be allowed to dry before application of the binder. Existing road markings, ironwork and road studs shall be suitably masked.

Application

9 The binder shall be sprayed on to a dry surface at a rate which will vary according to the texture and porosity of the surface. On a smooth close textured surface the amount of binder shall be not less than 1,35kg/m² or such rate specified by the resin manufacturer; on a more rugous surface a greater rate of spread may be required. Heated binders shall be allowed to cool before application of the aggregate. A mechanically metered plant shall be used to cover the binder uniformly with an excess of aggregate. Rolling of the aggregate is not permitted.

10 Hand application of the binder and/or aggregate shall not be permitted, except within areas not accessible to the mechanical sprayer and/or spreader. Where hand application is necessary, the proposed methods of batching, mixing and application of binder and/or aggregate to the road surface shall be agreed with the Employer's Representative.

Aftercare

11 The material used as masking shall be removed together with the binder sprayed

upon it and the remainder of the binder allowed to cure. During the curing period no disturbance or trafficking of the treated surface will be permitted. Before opening to traffic at the end of the curing period, the excess aggregate shall be removed by vacuum sweeper or other approved means.

12 The Contractor shall have regard to the increase in cure time of the resin binder with decrease in temperature in order to allow sufficient time for the resin binder to cure between the end of the spray operation and the time when the road is to be opened to traffic. Details of cure time variation of the resin with respect to temperature shall be supplied by the resin manufacturer.

Checking and Testing

13 A check shall be made by the Contractor at the end of each working shift to determine the quantities used of each binder component. The check shall be made by means of dip-sticks or other approved devices. The measured volumetric quantities of the components shall be converted to mass units to estimate the average rate of spread of binder upon the surface, by dividing the total mass of the components by the measured area of the surface treated. The net aggregate coverage rate shall also be recorded.

14 The average accuracy of batching shall be determined from the known used masses of the components. The relative proportions of components so determined shall fall within the limits specified in sub-clause 4 of this Clause.

15 The Contractor shall guarantee the adhesion to the underlying road surface and integrity of the high friction surfacing materials and workmanship for a period of five years from the date of opening the surfacing to traffic. This guarantee shall exclude defects arising from damage caused by settlement, subsidence or failure of the carriageway on which the surfacing has been applied.

925 Testing of Bituminous Mixtures

1 The demonstration of the conformity of asphalt mixtures specified in accordance with IS EN 13108 shall be covered by the following:

- IS EN 13108-20 Type testing; and
- IS EN 13108-21 Factory production control.

Type test reports shall be supplied to the Employer's Representative and factory production control records shall be submitted at weekly intervals during production of material for incorporation into the works.

2 The sampling and testing of bituminous mixtures shall comply with IS EN 12697, except where otherwise specified in this Series.

3 Any tests additional to those required by IS EN 13108–20, IS EN 13108–21 or the relevant MCDRW Clause are specified in Appendices 1/5 and/or 7/1.

4 Noting that factory production control applies up to the point of delivery, samples for quality assurance tests defined in Appendix 1/5 shall be taken from the delivery vehicle at the point of delivery. Half of these samples will be handed to the Employer for retention and possible future testing. The remainder of samples received shall be tested by the contractor with such testing being incorporated into the contractor's factory production control testing process.

926 Not Used

927 Not Used

928 Determination of the Complex Shear (Stiffness) Modulus (G*) and Phase Angle (δ) of Bituminous Binders using a Dynamic Shear Rheometer (DSR) Scope

1 This Clause describes the test method for the determination of the Complex Shear (Stiffness) Modulus (G*) and Phase Angle (δ) of a bituminous binder over a range of temperatures and frequencies when tested in harmonic, sinusoidal oscillatory shear mode using a dynamic shear rheometer (DSR) with parallel plate test geometry and where both plates are controlled at the same temperature. Two methods are described. The first is the conventional equilibrated temperature method using frequency sweeps and is detailed in the Institute of Petroleum (IP) test method IP PM CM/02 and with the amendments stated in this Clause shall be used for Type Approval (type testing) purposes. The second is the temperature sweep method, where the temperature of the binder is raised at a known rate and tested at a fixed frequency. The second test, which requires less time to perform, may be used for quality control purposes.

This Clause is applicable to unmodified and polymer modified binder as supplied, after the Rolling Thin Film Oven Test (RTFOT), after an Ageing Test or as recovered from a mixture. Bituminous binders containing fine mineral or organic matter or fibres may also be tested. For cutback bitumens, bituminous emulsions and polymer variants the binder shall be sampled from the delivery and a recovered binder prepared in accordance with the following:

Principle of the Rapid Recovery Test (RRT) for Bituminous Emulsions, cutbacks or Fluxed Binders - Polymer Modified or Unmodified

2 A thin film of binder is rotated in polytetrafluoroethylene bottles using the rolling thin film oven test apparatus (RTFOT), as described in IS EN 12607-1, to evaporate water from bituminous emulsion and/or the light solvent or highly volatile fraction from cutback, fluxed or other binder. Special screws are used to disturb the binder and maintain a homogenous material during breaking and/or curing. Nitrogen gas instead of air is jetted over the film of emulsion, cutback or fluxed binder and a lower temperature is used in order to minimise ageing effects and simulate the condition of the binder soon after application (it is assumed that these binders when used are not subjected to the high temperature mixing associated with an asphalt plant where the appropriate test is the RTFOT using air at 163ºC).

Definitions

3 For the purposes of this Clause the following definitions apply:

(i) Complex Shear Modulus (G*) (sometimes referred to as Complex Stiffness Modulus): ratio of peak stress to peak strain in harmonic, sinusoidal oscillation mode.

(ii) Phase Angle (δ): the phase difference between stress and strain in harmonic, sinusoidal oscillation mode.

(iii) Isotherm: an equation or curve on a graph representing the behaviour of the material at a constant temperature.

(iv) Linear region is defined as the range of strain over which the strain is directly proportional to the applied stress.

(v) High Equi-stiffness Temperature (T_{2kPa}): the temperature at which G* is equal to 2 kPa at 0,4 Hz determined from the plot of G* vs. temperature.

(vi) Low Equi-stiffness Temperature (T_{2MPa}): the temperature at which G* is equal to 2 MPa at 0,4 Hz determined from the plot of G* vs. temperature.

(vii) $G^*_{(pen)}$: the Complex Stiffness Modulus at 25°C and frequency 0,4 Hz.

(viii) $\delta_{(low)}$: the Phase Angle from the temperature equilibrated data at 5°C and at a frequency of 0,4 Hz.

(ix) $\delta_{(high)}$: the Phase Angle from the temperature equilibrated data at 60°C and at a frequency of 0,4 Hz.

(x) Black Diagram: a graph of the magnitude of G* against δ.

(xi) Zero-Shear-Viscosity: the limiting value of viscosity of a visco-elastic liquid at a given temperature and a very low shear rate such that the material in deforming does not build up any structural changes and maintains equilibrium in the linear region.

Apparatus

4 The apparatus for the test is detailed in IP PM CM/02. The rheometer and the temperature control system shall be calibrated and traceable to national standards, where applicable, at intervals not exceeding 13 months.

Determination of Complex Shear (Stiffness), Modulus (G*) and Phase Angle (δ)

5 Determination of G* and δ for binders used to manufacture products at temperatures above 120°C (for example asphalt) shall be as described in the IP method, except that the target strain shall be set within the range 0,005 and 0,02 and the sample preparation shall be Method A. For binders used at lower temperatures such as bituminous emulsions, or where volatile flux oil is present (for example cutback bitumen), the maximum 100°C and preferably less than 85°C. The IP Method shall be amended as follows:

6 Method for Emulsions and Cutbacks:

(i) Sample preparation: Warm the recovered binder obtained using Clause 923 sufficiently to be able to remove small quantities from the bulk using a suitable spatula or other tool (A temperature around the softening point or the High Equi-stiffness Temperature (T_{2kPa}°C) is usually found to be suitable). The binder shall not be heated above 100°C and not stored for longer than 1 hour at the target temperature. The binder shall be sealed with silicone release paper and/or metal foil to minimise ageing and loss of volatiles.

(ii) Sample loading: Weigh a pre-calculated amount of binder, to suit the geometry, directly onto one of the rheometer plates or onto a silicone-based material for subsequent transfer to one of the plates. The time for transfer shall be recorded.

(iii) Sample gapping: The plates shall be at the same temperature prior to setting the gap. The required gap shall be set

immediately and no trimming is required.

(iv) Allow the sample and both plates to equilibrate at a temperature above the softening point or T_{2kPa}°C for at least 15 minutes prior to commencement of the test.

(v) If the recovered binder is heavily modified such that the elastic properties prevent normal loading of the sample then a higher temperature shall be selected as near to 100°C as possible and this shall be reported in the test report.

Data Acceptability Criteria

7 The acceptability criteria detailed in the IP Method shall be used for different test geometries or for at least two samples.

8 If the acceptability criteria are not met for two samples then a third verification test shall be carried out, the shortened procedure may be used (25°C and frequency sweep) for the second and subsequent samples. If the acceptability criteria are met for the first and third tests, the results of the first test shall be accepted. If the acceptability criteria are met for the second and third tests, discard the results for the first test and continue testing the third sample by the full procedure used for the first sample, these results are verified by the second test. If none of the three tests are within the acceptability criteria then the mean of the results obtained in two full tests shall be reported with a note that the acceptability criteria could not be met.

Temperature Sweep Test Procedure for Quality Control

9 After equilibration of the sample above the softening point or the High Equi-stiffness Temperature (T_{2kPa}°C) for at least 15 minutes a temperature sweep shall be carried out from the lowest test temperature to at least 60°C or T_{2kPa}°C whichever is the higher. The test frequency shall be 0,4Hz (± 0,04Hz). G* and Phase Angle (δ) shall be measured at temperature intervals not greater than 5,5 °C. The rate of temperature increase shall be 2,5°C per minute or a lesser-fixed rate, which shall be stated with tolerances (not greater than ± 0,5°C).

10 The plot of G* and Phase Angle (δ) against temperature may be used to compare a sample with a type test for the product by the equilibrated temperature method. If the value for G* is within ± 30% and Phase Angle (δ) within ± 10 degrees at 25°C then the data is deemed to be valid for comparison. If not, then a second sample shall be tested, if the values for G* are within ± 30% and Phase Angle (δ) are within ± 10 degrees for 90% of the results for the first test the data is deemed to be valid and different to the type test. If the supplier has reasoned that higher tolerances are necessary for the particular product at Type Approval (type testing) stage these shall be used instead for comparison. The supplier may also state the sample preparation technique to be used for this comparison.

11 Alternatively the equilibrated temperature data from frequency sweeps (the IP method) may be used, although the number of equilibrated temperature tests at 0,4Hz will need to be increased (5°C intervals).

12 If required the temperature sweep shall be carried out with a reducing temperature from 80°C to the lowest test temperature in addition to the normal test, this shall be noted in the test report.

Expression of Results

13 A table of results, based on the individual test results, shall be produced which shall include the following information at each temperature:

(i) Test temperature ºC
(ii) Test frequency Hz
(iii) Strain %
(iv) Phase Angle (δ) Degrees
(v) Complex Stiffness Modulus (G*) Pascals.

14 A graph of G* against temperature shall be produced, in decades from 101 to 108 Pa as a curve at 0,4 Hz ± 0,04 Hz with a linear temperature x-axis of -10°C to 90°C.

15 A graph of Phase Angle (δ) against temperature shall be produced from 20 to 90 degrees ascending with a linear temperature x-axis of -10°C to 90°C at a frequency of 0,4Hz ± 0,04Hz.

16 A graph of G* against Phase Angle (δ) (Black Diagram) shall be produced in decades from 101 to 108 Pa with a linear x-axis of 90 to 20 degrees descending.

17 Plots of isotherms for G* against frequency tested at each test temperature shall be produced in decades from 101 to 108 Pa with an x-axis in decades of frequency from 10-2Hz to 101Hz.

18 Plots of isotherms for Phase Angle (δ) against frequency tested at each test temperature shall be produced from 20 to 90 degrees with an x-axis in decades of frequency from 10-2Hz to 101Hz.

19 The x-axes of the graphs shall have dimensions of at least 200mm and the y-axes at least 150mm.

20 The following test values shall be reported:

(i) T_{2kPa}: the High Equi-stiffness temperature.
(ii) T_{2Mpa}: the Low Equi-stiffness temperature.
(iii) $G^*_{(5°C)}$: the value of G* at the equilibrated temperature of 5°C and 0,4 Hz.
(iv) $G^*_{(pen)}$: the value of G* at the equilibrated temperature of 25°C and 0,4 Hz.
(v) $G^*_{(60°C)}$: the value of G* at the equilibrated temperature of 60°C and 0,4 Hz.
(vi) $\delta_{(low)}$: the value of δ at low temperature 5°C and loading time of 0,4 Hz.
(vii) $\delta_{(high)}$: the value of δ at high temperature 60°C and loading time of 0,4 Hz.
(viii) Zero-Shear-Viscosity at 45°C (ZSV_{45}) and 60°C (ZSV_{60}) calculated from the procedure outlined in a paper by Baumgaertel, M. and Winter, H.H., "Determination of discrete relaxation and retardation time spectra from dynamic mechanical data", Rheol Acta 28:511-519 (1989) or equivalent method with procedure outlined.

The complex stiffness modulus (G*) shall be reported to three significant figures, phase angle to the nearest 0,1 of a degree and temperature to 0,1°C.

Test Report

21 The test report shall contain at least the following information:

(i) A reference to this test procedure.
(ii) Place of test.
(iii) The rheometer type, model and test geometries (plates and gaps) used.
(iv) The compliance limitations of the machine/geometry (including whether software corrections have been applied in terms of the maximum sample stiffness at which the result reported will be in error by less than 10%). The limitations shall be reported for each plate geometry used to obtain the results reported.
(v) The type and identification of the product tested.
(vi) Sample thermal history: how, when and where the sample was taken; the size of the sample and whether it was sub-divided; the period it was stored and the conditions of storage; and whether it was treated by RTFOT and/or Ageing Test or was a recovered binder from emulsion or cutback in accordance with Clause 928 or recovered from an asphalt, with the recovery test method detailed.
(vii) Strain conditions of the test at 25°C and 0,4Hz and at the extremes of the temperature and frequency ranges used to provide data.
(viii) Sample loading method, temperature and time for transfer.
(ix) Frequency sweep direction for the IP method.
(x) Temperature sweep direction for the method if used and target rate of change with tolerances.
(xi) The results of the test as set out under this Clause.
(xii) Whether the Data Acceptability Criteria in this Clause were met.
(xiii) Any deviation, by agreement, or otherwise, from the procedure specified.
(xiv) Date of test.
(xv) Name of the person responsible for the test.

22 The test report and graphs, uniquely identified shall be provided to the Employer's Representative with the Contractor's Proposal.

23 A copy of the data in digital format suitable for graphical production shall be provided to the Employer's Representative.

929 Dense Base and Binder Course Asphalt Concrete (Design Mixtures)

1 Designed dense base and binder course asphalt concrete including HDM, shall be asphalt concrete conforming to IS EN13108-1, the detailed requirements of this clause for the selected mixture, and requirements specified in Appendix 7/1. The mixture designation shall be one of the following:

i) AC 32 HDM base 40/60 des
ii) AC 32 dense base 40/60 des
iii) AC 20 HDM bin 40/60 des
iv) AC 20 dense bin 40/60 des

2 When the mixture designation is not specified in Appendix 7/1, the mixture selected by the Contractor shall be notified to the Employer's Representative prior to its use in the Works.

3 The volumetric properties of designed base and binder course mixtures shall be as specified in IS EN 13108-1 and the following sub clauses.

4 Evaluation of conformity shall be carried out in accordance with IS EN 13108-1.

Void Content of Design Mixtures

5 When specified in Appendix 7/1, the volumetric properties of the mixture shall be monitored by determining the void content of cores compacted to refusal.

6 The void content of the mixture at target composition shall be determined from cores taken from a full scale trial strip not less than 30 m long and laid and compacted with full scale plant. This trial and the sampling testing protocol shall be in accordance with Annex C, BS 594987.clauses C.2.1, C.2.2, C.3, C.4.1 and C.4.2.

7 The mean air void content category of core pairs shall be V_{max7}. The mean air void content category of sets of six cores compacted to refusal shall be $V_{min0,5}$. If the mean air void content at refusal of any three consecutive pairs of cores falls below these targets, the mixture target composition shall be reviewed and the type test revalidated in accordance with BS 594987, Annex C.

Composition

8 For base and binder course mixtures, the target and/or minimum binder content is defined in Table 9/15.

9 The aggregate grading of the target composition shall fall within the envelope given in Table 9/15.

Aggregate

10 The coarse aggregate shall consist of crushed rock complying with Clause 901.4.

11 The fine aggregate shall comply with the requirements of IS EN 13043 Part 2.

12 The fine aggregate shall be either a 0/2 mm or a 0/4 mm aggregate fraction and be of one of the following types:

a) crushed rock fines produced from coarse aggregate defined in IS EN 13043 or
b) sand; or
c) a mixture of a) and b).

13 If added filler is used in dense mixtures it shall consist of crushed rock, crushed slag, hydrated lime, cement (CEM I or CEM II complying with IS EN 197-1).

Binder

14 The binder shall be petroleum bitumen of paving grade 40/60 or 70/100 Pen complying with IS EN 12591 as described in Appendix 7/1.

Resistance to Permanent Deformation of Design Mixtures

15 The resistance to permanent deformation of the mixture shall be in accordance with the appropriate class as specified in Appendix 7/1.

16 The resistance to permanent deformation shall comply with Table 9/16. Tests shall be carried out on specimens at the target composition using the small wheel tracking device on 305 mm square slabs which are compacted by a laboratory roller compactor in accordance with IS EN 12697-33. Alternatively, 200 mm diameter core specimens can be taken from a full scale trial strip in accordance with the trial strip protocol in Annex D, BS 594987.

17 When specified in Appendix 7/1, the resistance to permanent deformation of material laid in the Works shall be monitored by testing in accordance with clauses D 3.1, 3.2 and 3.3 of BS 594987 Annex D. Six cores shall be taken from the first kilometre length of material from each mixing plant and thereafter one further core from each subsequent lane kilometre. Results shall be assessed on successive rolling means of sets of six consecutive results and shall be deemed to conform if the mean is no greater than the specified value and individual values not more than 50% greater than the specified value.

Stiffness

18 Stiffness of the mixture shall be assessed in accordance with BS 594987, Annex E. Mixtures with 40/60 grade binder shall conform to category $S_{min1800}$ as defined in IS EN 13108: Part 1, clause 5.4.2.

Table 9/15 — Target limits for composition for AC 32 Base and AC 20 Binder Course design mixtures

	Design Mixtures	
Previous BS nomenclature:	**32 mm base**	**20 mm binder course**
New EN nomenclature:	**AC 32 DBM/HDM[a] base des**	**AC 20 DBM/HDM[a] bin des**
Test sieve aperture size (mm)	**% by mass Passing**	**% by mass Passing**
40	100	-
31,5	90 – 100	100
20	71 – 95	95 - 100
14	-	-
10	-	52 - 72
6,3	44 - 60	38 – 56
2	20 – 40	20 – 40
0,250	6 – 20	6 – 20
0,063 DBM	2 - 9	2 – 9
0,063 HDM	7 - 11	7 – 11
	Binder content B_{act}	
Aggregate type	**Minimum target**	**Minimum target**
Limestone	3,7	4,2
Other crushed rock	3,7	4,2
Gravel	4,2	4,5

[a] Delete as appropriate
[b] Single values are recommended to ensure consistency between the original BS 4987 mixtures and those derived from the European Standard.
[c] There is no requirement in IS EN 13108-21 to apply a conformity tolerance to an optional extra coarse or fine aggregate sieve. However, to monitor mixture consistency it may be appropriate for the producer to apply the same tolerance as that applied to the characteristic coarse or fine sieve.
(For Design mixtures B_{act} is the minimum target binder content.)

Table 9/16 — Limiting wheel-tracking requirements for Design Asphalt Concrete

Classification		Test temperature	Category WTS_{AIR}	Category PRD_{AIR}	Requirements	
		Test method	IS EN 12697-22, Small device, Procedure B	IS EN 12697-22, Small device, Procedure B	when tested to BS 598-110	
No.	Description	°C	Wheel track slope µm/cycle	Maximum rut depth (mm)	Max rut rate (mm/hr)	Max rut depth (mm)
1	Moderate to heavily stressed sites requiring high rut resistance	45	$WTS_{AIR\ DECLARED}$	$PRD_{AIR\ DECLARED}$	2	4
2	Very heavily stressed sites requiring very high rut resistance	60	$WTS_{AIR\ DECLARED}$	$PRD_{AIR\ DECLARED}$	5	7
3	Other sites	N/A	$WTS_{AIR\ NR}$	$PRD_{AIR\ NR}$	-	-

Notes:
The values for WTS_{AIR} and PRD_{AIR} categories in Table 9/16 shall be declared until experience with the test methods has been established in Ireland. It is therefore recommended that dual testing for resistance to permanent deformation be carried out with the method described in BS 598-110 and the method described in IS EN 12697-22 (small device) for a period of 24 months from the date of publication of SR28. After this time and following a review of the test results available, guidance will be given on the approved test method and appropriate specification limits. The values given in Table 9/16 for the British Standard method should be used until an acceptable correlation has been established The values given in Table 9/16 for the British Standard method should be used until an acceptable correlation has been established.

Compaction Control for the Works

19 Compaction shall be controlled and monitored in accordance with the general requirements of BS 594987 Clause 9.5.1 and the specific requirements of this Clause.

20 Compaction shall be continuously assessed using an indirect density gauge in accordance with BS 594987 Clause 9.4.2 with readings taken at 20m intervals in alternate wheel tracks. Gauge readings shall also be taken at each core location specified in sub clauses 24 and 26. Each gauge shall be individually calibrated on each mixture from each mixing plant and the calibrations shall be continually checked and updated based on correlations between gauge readings and core densities at the same locations.

21 For each location, the in situ void content shall be determined in accordance with IS EN 12697-8 using the bulk density from the gauge reading and a maximum density taken from the mixture type testing data and updated with values from testing in accordance with sub-Clause 23.

22 The average in situ void content calculated from any six consecutive indirect gauge readings shall not exceed 7%.

23 In the event of a failure to meet the requirements in sub-Clause 22, cores shall be taken at each location and void contents determined as described in sub-Clause 24 and the evaluation of the extent of any non conformity shall be based on these. If it is necessary to remove and replace any material

to restore conformity this shall be in lengths not less than 15m unless otherwise agreed by the Employer.

24 For the material from each mixing plant, a pair of cores shall be taken from the wheel tracks every 1000 metres laid and the void content shall be determined in accordance with BS 594987, clause 9.5.1.3.

25 The average in situ air voids for each core pair shall not exceed V_{max7}.

26 For the material from each mixing plant a pair of cores shall be taken every 250 metres laid, centred 100mm from the final joint position at any unsupported edge and the air void shall be determined in accordance with BS 594987, clause 9.5.1.3.

27 The average in situ void content for each of these pairs shall not exceed V_{max9}.

28 In the event of non conformity with sub-Clauses 25 or 27 then density readings with indirect gauges and, if necessary, further cores shall be taken to establish the extent. If it is necessary to remove and replace any material to restore conformity, this shall be in lengths not less than 15m unless otherwise agreed by the Employer.

29 Each core extracted shall be examined for evidence of excessive voids below the depth to which the indirect density gauge penetrates. If excessive voids are observed, further cores shall be taken to determine its extent.

30 Two copies of the final indirect density test results obtained and their correlation with in situ air void contents shall be passed to the Employer's Representative within 72 hours.

930 EME2 Base and Binder Course Asphalt Concrete

1 EME2 base and binder course asphalt concrete shall conform to IS EN13108-1, for the selected mixture, the requirements of this Clause and those specified in Appendix 7/1.

The mixture designation shall be one of the following:

i) AC 10 EME2 bin/base 10/20 des
ii) AC 10 EME2 bin/base 15/25 des
iii) AC 14 EME2 bin/base 10/20 des
iv) AC 14 EME2 bin/base 15/25 des
v) AC 20 EME2 bin/base 10/20 des
vi) AC 20 EME2 bin/base 15/25 des

2 When the mixture designation is not specified in Appendix 7/1, the mixture selected by the Contractor shall be notified to the Employer's Representative prior to its use in the Works.

3 Evaluation of conformity shall be carried out in accordance with IS EN 13108-1.

Binder

4 The binder shall be grade 10/20 or 15/25 Hard Paving Grade Bitumen in accordance with IS EN 13924 and the requirements specified in Tables 9/17, 9/18 and 9/19.

5 EME2 mixtures, otherwise conforming to IS EN 13108-1 and the detailed requirements of this clause, but using alternative paving grade bitumens or polymer modified paving grade bitumens, shall not be used without the design being approved by the National Roads Authority Standards Section.

6 The binder content at the target composition, determined in accordance with IS EN 12697-1, shall comply with the requirements of Table 9/20.

7 A separate assessment shall be made of the conformity of soluble binder content analysis results of EME2 mixtures using the principles of the 'mean of four results' approach used in IS EN 13108-21. Binder content shall be assessed on a continuous basis by taking the mean value of the previous four analysis results. This will give 'rolling mean binder content'. In addition to the analysis results meeting all of the standard conformity requirements of EN 13108-21, this rolling mean binder content shall comply with the target composition + 0,3%.

Table 9/17 Initial Binder Characteristics

Characteristic	Test Method	Unit	Hard Grade binders for EME 2		FPC
			10/20 pen	15/25 pen	Test frequency
Penetration at 25°C	IS EN 1426	0,1mm	10-20	15-25	D
Softening point	IS EN 1427	°C	58-78 Target Value 71max (1)	55-71 Target Value 68 max(1)	W
Penetration index, max	IS EN 13924 Annex A	-	+0,7 Target value +0,5max (1)	+0,7 Target value +0,5max (1)	W
Fraass Breaking point, max	IS EN 12593	°C	Target mean (2) 0 max Range -10 to +5	Target mean (2) 0 max Range -10 to +5	Q
Viscosity at 135°C, min	IS EN 12595	mm^2/s	1100	900	Q
Flash Point minimum	IS EN 2592	°C	245	245	A
Solubility, minimum	IS EN 12592	%(m/m)	99,0	99,0	A

Notes:
(1) Target max value based on a rolling mean of the last 6 consecutive results in compliance testing or FPC as appropriate.
(2) Target max value based on a rolling mean of the last 3 consecutive results in compliance testing or FPC as appropriate.
All tests to be carried out on sub-samples of a single bulk sample of binder.
Minimum test frequency: D = Daily, W = Weekly, Q = Quarterly, A = Annually.
(Indicated frequencies apply only if product is in regular supplied).

Table 9/18 Binder Characteristics, after short term ageing to EN1260-1 (RTFOT)

Characteristic	Test Method	Unit	Hard Grade binders for EME 2		FPC
			10-20 pen	15-25 pen	Test Frequency
Change of Mass, Max		%	0,5	0,5	A
Retained pen 25°C, min	IS EN 1426	%	65	65	Q
Increase in softening point, maximum	IS EN 1427	°C	8	8	Q
Fraass breaking point min	IS EN 12593	°C	Target Mean (1) +2 max range -8 to +7	Target Mean (1) +2 max range -8 to +7	Q

Notes:
(1) Target max value based on a rolling mean of the last 3 consecutive results in compliance testing or FPC as appropriate.
All tests to be carried out on sub-samples of a single bulk sample of binder.
Minimum test frequency: Q = Quarterly, A = Annually.
(Indicated frequencies apply only if product is in regular supply).

Table 9/19 Binder Characteristic To Be Reported

Characteristic	Test Method	Unit	Binder for EME2	FPC frequency		
				AS	STA	LTA
Brookfield Viscosity T200 cP	IS EN 13302	°C	TBR	A		
T2000 cP		°C	TBR		A	
T5000cP		°C	TBR		A	
G* and Phase Angle	prEN 14770	Pa, degrees	TBR	A	A	A
VPT Temperature, G' =G", at 0,4Hz		°C	TBR	A	A	A
G* at the VPT temperature	Clause 928	Pa	TBR	A	A	A
G' and G2 Master curves 80°C to 0°C	Graphical output	Graphical Output	TBR	A	A	A
G2 & phase angle at 15°C, 10Hz and 20°C, 1Hz		Pa, Degrees	TBR	A	A	A
$T_{s=300Mpa}$, by BBR	prEN 14771	°C	TBR	Q	Q	Q
$T_{m=0,3}$, by BBR		°C	TBR	Q	Q	Q
Pendulum Cohesion, min	SRW Cl 939 (reported graphically)	J/Cm²	TBR	Q	Q	Q

Notes:
AS = As Supplied; STA = After EN12607-1 (RTFOT) * LTA = After PAV85 *
*An ageing profile determined in accordance with SRW Cl 923 is an acceptable alternative to STA and PAV85.
All tests to be carried out on sub-samples of a single bulk sample of binder. Minimum test frequency: Q = Quarterly, A = Annually. (Indicated frequencies apply only if product is in regular supply).

Table 9/20 — Target limits for composition for EME2 Base and Binder Course Mixtures

Mix Designation	AC 20 EME2	AC 14 EME2	AC 10 EME2
Test sieve aperture size mm	% by mass passing	% by mass passing	% by mass passing
31,5	100	-	
20	90 – 99	100	
14	70 – 95	90 – 99	100
10	55 – 90	–	90 – 99
6,3	42 – 75	42 – 65	60 – 80
4	-	-	35 – 65
2	18 – 35	19 – 42	27 – 42
0,250	8 – 18	8 – 18	8 – 18
0,063	5 – 9	5 – 9	5 – 9
	Binder content B_{act}		
	Minimum target	Minimum target	Minimum target
	5,1	5,3	5,5

Aggregate

8 The aggregate grading of the target composition shall fall within the envelope given in Table 9/20. The aggregate grading curve shall be continuous and shall not vary from the low limit on one size of sieve to the high limit on the adjacent sieve or vice versa.

9 The coarse aggregate shall consist of crushed rock complying with Clause 901.4.

10 The fine aggregate shall comply with the requirements of IS EN 13108 Part 2.

11 The fine aggregate shall be either a 0/2 mm or a 0/4 mm aggregate fraction and be of one of the following types:

a) crushed rock fines produced from coarse aggregate defined in IS EN 13043 or
b) sand; or
c) a mixture of a) and b).

12 If added filler is used in dense mixtures it shall consist of crushed rock, crushed slag, hydrated lime, cement (CEM I or CEM II complying with IS EN 197-1).

13 All aggregate shall be in a surface dry condition prior to mixing.

Void Content

14 The void content of specimens compacted in the gyratory compactor in accordance with IS EN 12697–31, using the appropriate number of gyrations from Table 9/21, from mixtures at target composition prepared in the laboratory in accordance with IS EN 12697-35 shall be as follows:

Table 9/21 — Number of Gyrations

Mix type	Number of gyrations
AC 10 EME2	80 gyrations
AC 14 EME2	100 gyrations
AC 20 EME2	120 gyrations

15 The void content of the mixture at target composition shall be determined from cores taken from a full scale trial strip not less than 30 m long and laid and compacted with full scale plant. This trial and the sampling and testing protocol shall be in accordance with Annex E, BS 594987.

16 The average void content category of core pairs shall be $V_{max6,0}$.

Water Sensitivity

17 Water sensitivity (IS EN 12697-12) is specified in terms of the ratio of the indirect Tensile Strengths (IS EN 12697-23) of compacted cylinders of the mixture, determined from soaked and unsoaked specimens conditioned at 25°C.

18 The IS EN 12697-12 water sensitivity test is not considered suitable for EME2 mixtures. Therefore the Duriez Test shall be applied as follows: 'The retained strength of specimens manufactured at target composition and tested in accordance with the Duriez test to NF P 98 251 1 shall be not less than 0,75.'

Deformation Resistance

19 For EME2 mixtures both the small device and the large device methods described in IS EN 12697-22 shall be carried out and the results reported for a period of 24 months from the date of publication of SR28. After this time and following a review of the test results available, this requirement may be amended. The deformation resistance of the mixture, at target composition, tested in accordance with the large wheel tracking test to IS EN 12697-22, Large Device, shall conform to category $P_{7,5}$.

20 Testing of materials on the large wheel tracking device requires the preparation of test specimens (slabs), compacted in accordance with IS EN 12697-33. This method permits the test laboratory to establish a roller compaction pattern, which must be symmetrical, in order to achieve the air void requirement. For EME2, the target void content shall be 4,5%, with compaction of the slabs deemed to be acceptable for wheel tracking testing if the void content V is between 3% and 6%, when determined in accordance with IS EN 12697-8, Procedure A (Bulk dry density) of IS EN 12697-6, and IS EN 12697-5.

Stiffness Modulus

21 The mean Indirect Tensile Stiffness Modulus determined from cores taken from a full scale trial strip not less than 30 m long and laid and compacted with full scale plant shall conform to category Smin5 500. This trial and the sampling and testing protocol shall be in accordance with Annex E, BS 594987.

Fatigue Properties

22 For EME2 mixtures with a richness modulus as defined in Annex E, BS 594987 equal to or greater than 3,6, resistance to fatigue shall be $\varepsilon_{6\text{-NR}}$.

23 For EME2 mixtures with a richness modulus of less than 3,6 resistance to fatigue shall be assessed as follows:

- the resistance to fatigue of specimens shall be prepared in accordance with clause 6.4 of IS EN 13108-20,
- testing shall be in accordance with I.S. EN 12697-24:2004, Annex A (2PB TZ).
- Microstrain for 10^6 cycles at 10°C and 25 Hz shall conform to category $\mathcal{E}_{6\text{-}130}$,
- the compaction of test specimens shall be selected from Table C.1 of IS EN 13108-20,
- the void content of the specimens shall be between 3,0 and 4,0%.

Compaction

24 EME2 shall be delivered to site at a temperature which enables laying with a minimum paver-out temperature of 140°C.

25 EME2 mixtures shall be compacted with either

(i) Steel rollers exceeding 8 tonnes, provided compaction is speedily undertaken. Any vibration shall be switched off when traversing compacted material to avoid micro-cracking the cooling surface,

or

(ii) Pneumatic tyred rollers (PTR's) weighted at a minimum of 1,0 tonne per wheel, finishing with wide steel non-vibrating rollers and 3- point rollers.

26 Compaction must be substantially completed before the temperature falls below 120°C. Limited rolling without vibration may be carried out below this temperature to improve the finish.

Compaction Control for the Works

27 Compaction shall be controlled and monitored in accordance with the general requirements of BS 594987 9.5.1 and the specific requirements of the following sub-clauses.

28 Compaction shall be continuously assessed using an indirect density gauge in accordance with BS 594987 9.4.2 with readings taken at 20m intervals in alternate wheel tracks. Gauge readings shall also be taken at each core location specified in sub clauses 32 and 34. Each gauge shall be individually calibrated on each mixture from each mixing plant and the calibrations shall be continually checked and updated based on correlations between gauge readings and core densities at the same locations.

29 For each location, determine the in situ void content in accordance with IS EN12697-8 using the bulk density from the gauge reading and a maximum density taken from the mixture type testing data and updated with values from testing in accordance with sub clauses 31 and 32.

30 The average in situ void content calculated from any six consecutive indirect gauge readings shall not exceed 6%.

31 In the event of a failure to meet the requirements in sub clause 30, cores shall be taken and void contents determined in accordance with BS 594987 clause 9.5.1.3 and the evaluation of the extent of any non conformity shall be based on these. If it is necessary to remove and replace any material to restore conformity this shall be in lengths not less than 15m unless otherwise agreed by the Employer.

32 For the material from each mixing plant a pair of cores shall be taken from the wheel tracks every 1000 metres laid and the void content shall be determined in accordance with BS 594987 clause 9.5.1.3.

33 The average in situ air voids for each core pair shall not exceed 6%.

34 For the material from each mixing plant a pair of cores shall be taken every 250metres laid, centred 100mm from the final joint position at any unsupported edge and the air void shall be determined in accordance with BS 594987 clause 9.5.1.3.

35 The average in situ void content for each of these pairs shall not exceed 8%.

36 In the event of non conformity with sub clauses 33 or 35 then density readings with indirect gauges and, if necessary, further cores shall be taken to establish the extent. If it is necessary to remove and replace any material to restore conformity this shall be in lengths not less than 15m unless otherwise agreed by the Employer.

37 Each core extracted shall be examined for evidence of excessive voids below the depth to which the indirect density gauge penetrates. If excessive voids are observed, further cores shall be taken to determine its extent.

38 Two copies of the final indirect density test results obtained and their correlation within situ air void contents shall be passed to the Employer's Representative within 72 hours of the material being laid.

931 Not Used

932 Not Used

933 Not Used

934 Not Used

935 Not Used

936 Not Used

937 Stone Mastic Asphalt (SMA) Regulating Course

General

1 Stone Mastic Asphalt regulating course shall conform to IS EN 13108-5, the requirements of this Clause and those specified in Appendix 7/1. The mixture designation shall be one of the following, and shall only be used within regulating courses:

i) SMA 6 bin 70/100 reg
ii) SMA 6 bin PMB 65/105-60 reg
iii) SMA 10 bin 40/60 reg
iv) SMA 10 bin 70/100 reg
v) SMA 10 bin PMB 65/105-60 reg
vi) SMA 14 bin 40/60 reg
vii) SMA 14 bin 70/100 reg
viii) SMA 14 bin PMB 65/105-60 reg

2 When the mixture designation is not specified in Appendix 7/1, the mixture selected by the Contractor shall be notified to the Employer's Representative prior to its use in the Works.

3 Evaluation of conformity shall be carried out in accordance with IS EN 13108-5.

Binder

4 The binder shall be paving grade bitumen conforming to IS EN 12591 or polymer modified bitumen conforming to IS EN 14023.

5 The permitted grades for SMA regulating course are 40/60 or 70/100 penetration grade and polymer modified bitumen PMB 65-105/60 (in accordance with table 9/33).

Aggregates

6 The coarse aggregate, including crushed gravel, shall be material substantially retained on a 2 mm test sieve and shall conform to all appropriate requirements of IS EN 13043.

7 The fine aggregate shall comply with the requirements of IS EN 13043.

8 The fine aggregate shall be either a 0/2 mm or 0/4 mm aggregate and be of one of the following types:

a) fines produced by crushing the course aggregate material specified in this clause;
b) a mixture of fines as in a) above and natural sand subject to a maximum sand content of 50%.

Added Filler

9 Added filler shall be in accordance with IS EN 13043. Added filler includes crushed rock, crushed slag, hydrated lime, cement or other material as agreed with the specifier.

10 The loose bulk density in kerosene of added filler, with the exception of hydrated lime, shall be in accordance with clause 5.5.5 of IS EN 13043.

Reclaimed Asphalt

11 Reclaimed asphalt shall not be used within SMA mixtures unless otherwise approved by the National Roads Authority.

Additives

12 Additives permitted for inclusion include: fibres, special fillers, pigments and adhesion or modifying agents. The suitability of such additives shall be demonstrated in accordance with clause 4.1, IS EN 13108-5. The Contractor shall submit data sheets giving details of the properties of the binder additives proposed, including those specified in Appendix 7/1.

Composition

13 Evaluation of conformity shall be carried out in accordance with IS EN 13108 -1 which requires specifications to be presented as a grading envelope within which the producer's declared target grading must fall. The

grading specification in Table 9/22 gives single point and/or very narrow envelope gradings, which, in combination with the tolerances from IS EN 13108-21 result in overall grading envelopes similar to those previously specified in BS 4987.

14 The target and/or minimum binder content for regulating course mixtures is defined in Table 9/22.

15 The aggregate grading of the target composition shall fall within the envelope given in Table 9/22.

Compaction Control for Works

16 Control testing for compaction and resistance to permanent deformation shall be carried out in accordance with BS 594987 section 9.5.3.

Table 9/22 — Target limits for composition for SMA Regulating Course

Mix Designation	SMA 6	SMA 10	SMA 14
Test sieve aperture size (mm)	Passing sieve (% by mass)		
31,5	-	-	-
20	-	-	100
14	-	100	90 - 100
10	100	90 - 100	35 - 60
6,3	90 – 100	30 - 55	20 - 45
4	22 – 45	-	-
2	20 – 34	20 - 35	15 - 30
0,063	8 – 14	6 - 12	6 - 12
Minimum Target Binder Content (% by mass of total mixture) B_{act}			
Penetration Grade Bitumen	6,3	5,7	5,5
Polymer Modified Bitumen	5,8	5,3	5,3

Table 9/23 – Temperature limits of the mixture

Paving grade of binder	Temperature °C	
	Recommended minimum discharge at plant	Maximum
40/60	160	200
70/100	140	180
Polymer Modified Binders	See NOTE 1	See NOTE 1

Notes:
1 When using modified bitumen or additives, different temperatures may be applicable and advice should be sought on the mixing & handling temperatures from the binder manufacturer. These temperatures shall be documented and declared as part of the type testing report.

Table 9/24 – Nominal and minimum compacted layer thicknesses for SMA regulating course mixtures

Material Description	BS EN 13108-5 Reference	Coarse Aggregate Size (mm)	Nominal Layer Thickness (mm)	Minimum Thickness at any point (mm)
SMA 6	SMA 6 bin	6	15-40	10
SMA 10	SMA 10 bin	10	20-50	15
SMA 14	SMA 14 bin	14	30-60	25

Temperature

17 When using paving grade binder, the temperatures of the mixture, measured according to IS EN 12697-13, shall be within the limits of Table 9/23. The maximum temperature applies at any place in the plant. The minimum temperature applies at discharge from the mixer and is included for guidance only. The minimum temperature at delivery shall be declared by the manufacturer. This information would normally be declared in the type test report.

Thickness

18 The nominal thickness of a layer and the minimum thickness of a layer at any point shall conform to the thicknesses given in Table 9/24. It should be noted that thicknesses in excess of those given in the table can provide better compaction if adequate equipment is used but could lead to problems with surface irregularity and level control.

Coating and Homogeneity

19 When discharged from the mixer, the material, including any additives, shall be homogenous with the aggregate completely coated with binder. Particular attention should be paid to the potential for binder drainage in SMA mixtures which shall be avoided in all circumstances.

Binder Drainage

20 Binder drainage is determined in accordance with clause 5 of IS EN 12697-18, (Schellenberg method). Maximum binder drainage category of a set of specimens shall be $D_{0,3}$.

21 Stabilising additives (fibres) shall be included when the mixture contains penetration grade bitumen. When the mixture contains polymer modified bitumen, the requirement for stabilising additives shall be determined and agreed with the Employer.

Void Content

22 The compaction of the test specimens shall be selected from Table B.5, IS EN 13108-20. The void content shall be determined in accordance with Table B.5, IS EN 13108-20.

23 The minimum void content category of a set of three specimens is: $V_{min}2$; The maximum void content category of a set of three specimens is: $V_{max}8$.

Water Sensitivity

24 Water sensitivity (IS EN 12697-12) is specified in terms of the ratio of the indirect Tensile Strengths (IS EN 12697-23) of compacted cylinders of the mixture, determined from soaked and unsoaked specimens conditioned at 25°C.

25 Water sensitivity of SMA binder course and regulating mixtures shall be ITSR80.

Resistance to Permanent Deformation

26 The resistance to permanent deformation at the target composition determined from tests with the small wheel tracking device on 305 mm square slabs which are compacted by a laboratory roller compactor, in accordance with IS EN 12697-33 shall meet the criteria set out in Table 9/25. Alternatively, 200 mm diameter core specimens taken from a full scale trial strip in accordance with the trial strip protocol in BS 594987.

Bond Coat

27 Polymer modified bond coats shall be used.

Table 9/25 — Limiting wheel-tracking requirements for SMA Regulating Course

Classification		Test temperature	Category WTS_{AIR}	Category PRD_{AIR}	Requirements when tested to BS 598-110	
		Test method	IS EN 12697-22, Small device, Procedure B	IS EN 12697-22, Small device, Procedure B		
No.	Description	°C	Wheel track slope µm/cycle	Maximum rut depth (mm)	Max rut rate (mm/hr)	Max rut depth (mm)
1	Moderate to heavily stressed sites requiring high rut resistance	45	$WTS_{AIR\ DECLARED}$	$PRD_{AIR\ DECLARED}$	2	4
2	Very heavily stressed sites requiring very high rut resistance	60	$WTS_{AIR\ DECLARED}$	$PRD_{AIR\ DECLARED}$	5	7
3	Other sites	N/A	$WTS_{AIR\ NR}$	$PRD_{AIR\ NR}$	-	-

Note:
The values for WTS_{AIR} and PRD_{AIR} categories in Table 9/25 shall be declared until experience with the test methods has been established. It is therefore recommended that the test method described in BS 598-110 be used in conjunction with the EN method, and that the results be correlated with results obtained on the same mixtures. The values given in Table 9/25 for the British Standard method should be used until an acceptable correlation has been established.

938 Porous Asphalt

1 Porous Asphalt shall conform to IS EN 13108-7, the detailed requirements of this Clause and those specified in Appendix 7/1. The mixture designation shall be:

(i) PA 14 surf PMB des

2 Porous asphalt is exclusively a bituminous surface course material used in road construction to reduce surface water spray and road-tyre noise. The mixture is gap-graded containing 14mm nominal size aggregate and the binder is polymer modified. The mixture shall satisfy the composition requirements as set out in the following sub-Clauses, and the mandatory tests specified in Table 9/30. The surface course is normally laid on an impervious binder course or other impermeable surfacing having sufficient crossfall and longitudinal gradients to facilitate surface water removal. The nominal compacted layer thickness is 45mm. The layer is bonded to the underlying layer with a polymer modified bonding coat.

3 Evaluation of conformity shall be carried out in accordance with IS EN 13108-7.

Aggregate

4 The coarse aggregate shall consist of crushed rock or crushed gravel complying with the requirements of Clause 901.4. When tested in accordance with the procedures of IS EN 933-3, IS EN 2097-2 and IS EN 1097-8 each source of coarse aggregate shall as a minimum have the properties described in Table 9/26 or such increased requirement as stated in Appendix 7/1. The fine aggregate shall be crushed rock fines or natural sands or a mixture thereof. The use of reclaimed asphalt shall not be permitted.

5 The requirements of the grading shall be expressed in terms of the target grading which shall be within the limits stated within Table 9/27. The agreed grading for the mixture shall be obtained by applying the tolerances given to the target aggregate grading. The grading curve of the aggregates shall be broadly parallel to the limits of the envelope and shall not vary from the low limit on one size of sieve to the high limit on the adjacent sieve or vice-versa.

Filler

6 At least 2,0% by mass of the total aggregate shall be hydrated lime filler. The minimum calcium and magnesium hydroxide content of the hydrated lime shall be 90%.

Table 9/26 Porous Asphalt Coarse Aggregate Properties

Property	Category
Polished Stone Value (PSV)	$PSV\ 60_{declared}$
Resistance to Fragmentation (Los Angeles Test)	LA_{25}
Aggregate Abrasion Value (AAV)	AAV_{10}
Flakiness Index (10 – 14mm fraction)	FI_{15}
Flakiness Index (6,3 – 10mm fraction)	FI_{20}

Table 9/27 — Target limits for composition for PA 14 surf PMB

Mix Designation	PA 14 surf PMB
Test sieve aperture size (mm)	**% by mass passing**
20	100
14	90 - 100
10	55 – 75
6,3	15 – 25
2	10 - 17
0,063	4 – 5,5 [A)]
Binder Content B_{act}	5,3
Binder grades	PMB

[A)] Including 2 % of hydrated lime by weight of total aggregate

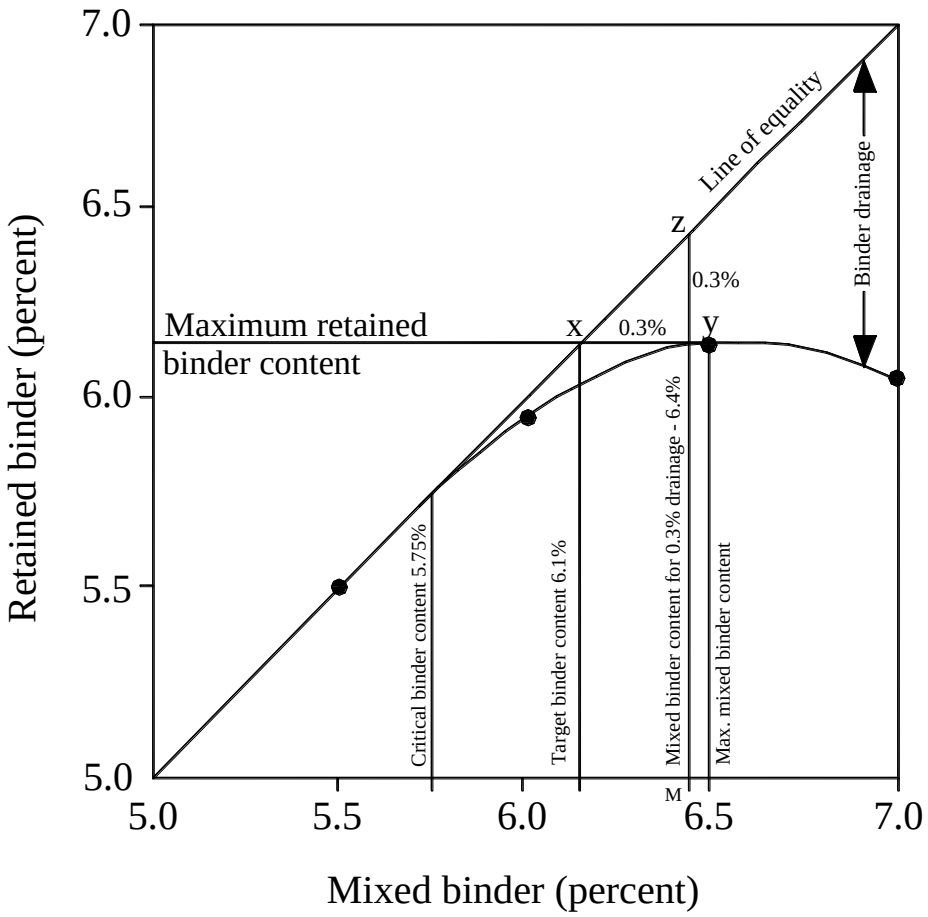


Figure 9/1: Binder drainage test plot - Diagram indicating definitions

Binder

7 The binder shall be preblended polymer modified bitumen and shall comply with the selected requirements of IS EN 14023 as detailed in Table 9/28. During storage the binder shall be agitated / circulated in accordance with the manufacturer's instructions to ensure the homogeneity of the binder. When tested in accordance with Clause 941, 'Modified Binder Storage Stability Test' preblended modified binders shall meet the original specification for softening point and penetration for that binder after the four day storage period. The supplier shall ensure the preblended modified binder is manufactured to the same specification as that for the sample submitted for the 'Binder Drainage Test', in accordance with IS EN 12697-18 (Basket Method).

The quantity of binder lost through drainage, after a specified time at the maximum mixing temperature, shall be measured in duplicate for mixes with the same aggregate contents but with different binder contents. The target binder content shall be defined as the value 0,3 per cent less than that at which 0,3 per cent binder drainage occurs.

From Figure 9/1, the mixed binder content (M) shall be determined where the binder drainage is 0,3 per cent (yz). The target binder content shall be (M-0,3) per cent. As a check, the abscissa, (xy), should also equal 0,3 per cent between the line of equality and the point on the drainage curve where the binder drainage is 0,3 per cent (yz).

Binder Content

8 The target binder content (polymer modified bitumen) as defined in Table 9/27 shall be established from binder drainage tests as described in IS EN 12697-18 (Basket Method) and in accordance with sub clause 8 and Figure 9/1. In addition, at the target binder content the porous asphalt mixture shall comply with the requirements of the Cantabro Wear Test as specified in sub- Clause 938.19, with the Water Sensitivity Test as specified in sub-clause 938.18 and with the Relative Hydraulic Conductivity requirements as specified in Clause 938.16. The tolerance for the binder content to be used in the Works

shall not exceed ±0,3% of the target value. Notwithstanding the above requirements the found binder content on analysis shall not be less than 5% of the total mixture.

Additives

9 Inorganic or organic fibres may be used to assist in preventing binder draining from the aggregate. Adhesion agents or other additives may be added to the binder to improve the stripping resistance of the mixture. The suitability of such additives shall be demonstrated in accordance with clause 4.1, IS EN 13108-7.

Mixing

10 The constituent materials shall be accurately weighed into a mechanical mixer of approved type and thoroughly mixed in such a manner that all particles are completely coated. All weighing mechanisms shall be properly maintained within the accuracy's recommended by the manufacturer. The Contractor shall supply a service certificate showing that the weighing devices have been calibrated against standard loads, in accordance with the quality plan and audited to IS0 9001, within six months prior to the Contract Date. The mixing temperature shall be as shown in Table 9/29 and this is based on a required binder viscosity of 0,5Pas. To minimize temperature fluctuations, production shall be continuous, and where practicable, not interrupted.

Transporting

11 Porous asphalt shall be transported to site in double-sheeted insulated vehicles with tight fitting covers. To facilitate discharge of porous asphalt, the floor of the vehicle may be coated with the minimum of liquid soap, vegetable oil, or other non solvent solution. When a coating is used then, prior to loading the body shall be tipped to its fullest extent, with the tailboard open, to ensure drainage of any excess. The floor of the vehicle shall be free from adherent bituminous materials or other contaminants. Porous asphalt shall be delivered to site within the temperature range shown in Table 9/29.

Bonding Coat

12 Notwithstanding the advice provided in Clause 920, the following should apply. On all occasions that porous asphalt is used the substrate should be sprayed with a polymer modified bitumen emulsion bonding coat. The rate of application of the bonding coat shall be such as to ensure that the residual bitumen coverage, after curing, is between 0,4kg/m^2 and 0,7kg/m^{2}The bonding coat shall be allowed to break before porous asphalt is laid and shall be of a composition to prevent 'pick up' on the tyres of pavers and delivery trucks.

Laying

13 Porous asphalt shall be laid by machine and compacted within three hours of mixing. The thickness of the porous asphalt layer, after compacting, shall be 45 +/- 5 mm. Where more than one lane is to be covered, and where possible, porous asphalt shall be laid by at least two pavers working in echelon, so that longitudinal joints can be effectively rolled together whilst hot. The stagger between paving machines shall not exceed 20 metres. Bitumen coating shall not be applied to exposed longitudinal edges. 'Throwing-back' of material and walking on the uncompacted porous asphalt shall be avoided. Except in circumstances approved by the Employer's Representative all construction plant must be kept off the surface before opening to traffic in order to prevent damage to and clogging of the material. Porous asphalt shall not be laid during heavy and/or persistent rain or when standing water is present. Porous asphalt shall be laid within the limits of air temperature and wind speed stated in Figure 9/2. Laying shall not be permitted at any temperature if the average wind speed over the preceding hour exceeds 50km/h at 10m height (40km/h at 2m height). Wind speed shall be measured either by anemometer erected at a height of 10m ± 0,5m situated at the site office, or by portable anemometer erected at a height of 2m ± 0,1m situated in close proximity to the laying works. The anemometer shall be fitted with a digital accumulative device.

Compacting

14 Porous asphalt shall be compacted using at least two 6-8 tonne, non-vibrating, steel wheel tandem drum rollers for each paving machine. If a vibratory type roller is used it shall be operated in the non-vibrating mode. To avoid pick-up, the rollers drum surfaces shall be initially clean and completely wetted prior to and during rolling. Rubber tyred rollers and 3-wheeled rollers shall not be used. Rolling shall commence at the highest mat temperature consistent with no shoving and shall be substantially completed within the temperature range given in Table 9/29. The first roller pass shall be on the low edge of the mat, followed by the high edge. Rolling of the rest of the mat shall then proceed from low to high side and shall continue until all roller marks have been removed.

Longitudinal and Transverse Joints

15 Wherever possible pavers shall be used in echelon, as described in sub-clause 13 of this Clause, to eliminate longitudinal joints. Where exposed longitudinal joints are unavoidable they may be cold butted, provided that the edge of the porous asphalt layer laid previously has not been damaged and is clean. Where damage to edges has occurred they shall be trimmed by power saw with appropriate measures including suction extraction, to prevent clogging of the pores with detritus. Longitudinal joints shall be placed adjacent to pavement lane markings or outside wheel track zones and shall be formed by butting-up to the adjacent porous asphalt to form a tight joint. Transverse joints shall be formed against a 200mm wide and 45mm thick hard timber stop-end nailed to the road surface in advance of the paving operation. The cutting of edges shall be avoided but where transverse edge cutting is essential, only sawing with appropriate measures, including suction extraction shall be permitted. Nothing shall be done, nor any articles positioned, such as to impede the run-off water freely entering the drainage channel or filter drain provided to remove the water from the pavement surface edge. Where an impermeable surface is to be laid downstream of the porous asphalt, the lane ends of the porous asphalt shall be staggered across the carriageway in the direction of the drainage path in order to prevent excess rainwater from welling up over the transverse joint.

Relative Hydraulic Conductivity

16 After the porous asphalt has cooled to ambient temperature, and before trafficking, the relative hydraulic conductivity of the material shall be measured, in accordance with the procedures specified in Clause 940. The average value, from any 5 consecutive determinations at 20m spacing in the near-side wheel track of each lane of a carriageway, shall be not less than $0{,}12 s^{-1}$ and no single value shall be less than $0{,}08 s^{-1}$''.

17 Whilst the above testing will take contractual precedence additional European in-situ drainability testing shall be carried out in accordance with IS EN 12697-40.

Water Sensitivity

18 The water sensitivity shall be determined in accordance with IS EN 12697 Parts 12 & 23. The ratio of wet to dry strength shall not be less than $ITSR_{80}$. The specimen compacting procedure shall be such as to provide the air voids content expected in the field, i.e. in the range 20-28 percent without causing significant crushing of the large aggregate particles as observed from analysis of the specimens and measurement of any reduction in size. A reduction such that the grading no longer lies within the grading envelope shall not be acceptable.

Particle Loss (Cantabro Wear Test)

19 When tested in accordance with the procedure described in IS EN 12697-17 the wear of the mixture shall not exceed PL_{20}, 20% at 25°C.

(i) The Cantabro test shall be carried out on mixture specimens unconditioned by any simulated ageing procedures or by soaking in water and,

(ii) The specimen compaction shall achieve maximum air voids up to 28 per cent without causing significant crushing of the coarse aggregate as defined in sub-clause 18 of this Clause.

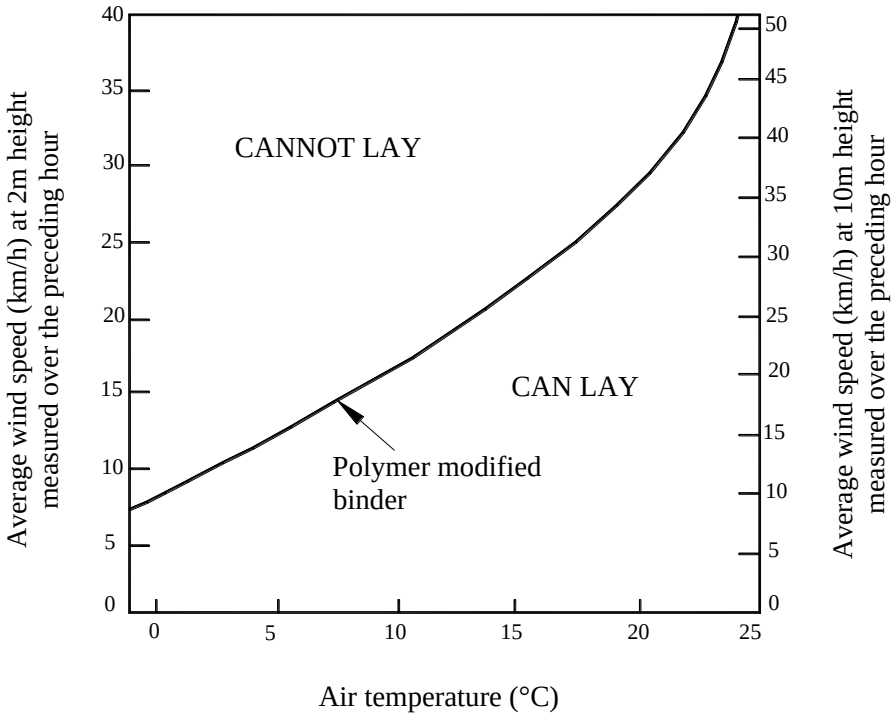


Figure 9/2: Limiting weather conditions for laying porous asphalt

Table 9/28: Properties of Polymer Modified Porous Asphalt Binder

Properties	Test Method	Specified Value
Penetration at 25°C 0,1mm	IS EN 1426	60 – 105
Softening Point °C	IS EN 1427	>70
Fraass Brittle Point °C	IS EN 12593	< -12
Storage Stability, °C difference in softening point, top-bottom, after four days at 160°C	Clause 941	<5
Resistance to hardening (Rolling Thin-film Test) Mass Change (percent).	IS EN 12607:1	<1,0
Retained Penetration (percent)	IS EN 1426	>60
Retained softening point increase (°C)	IS EN 1427	<8
Retained softening point decrease (°C)	IS EN 1472	<2

Table 9/29: Mixing and Handling Temperatures

Binder Type	Mixing Temperature Range (°C)	Delivery Temperature Range (°C)	Minimum Compacting Temperature (°C)	
			Start	Finish
Polymer modified	In accordance with manufacturers' requirements 150(A) - 190	145 - 170	140	115

(A) Minimum temperature applies at discharge from the mixer and is included for guidance only.

Table 9/30 Mandatory design tests required on Porous Asphalt Mixtures

Design Tests	Parameter	Performance Levels	Applicability of Test
Grading	Target composition in accordance with Table 9/27.	Percentage by mass passing	Design & Quality Control
Binder Drainage Test at 170°C	Drainage characteristics of the binder from asphalt mixture in accordance with IS EN 12697 Part 18	Target binder content	Design & Quality Control
Percent Air Voids	Void Content in accordance with IS EN 12697-8	Max air void content 28 percent. Min air void content 20 percent	Design
Relative hydraulic conductivity	Measurement of water outflow in accordance with Clause 940	Relative Hydraulic Conductivity Ave. 0,12 seconds (min value 0,8s)	Design & Quality Control
Water Sensitivity Test*	Tensile strength test in accordance with IS EN 12697 Parts 12 & 23	$ITSR_{80}$	Design
Cantabro Wear Test*	Percent loss in accordance with IS EN 12697-17	PL_{20},20% at 25°C (20% at 25°C)	Design

* The specimen compaction procedure shall be such as to provide a maximum air void content of 28 percent. The procedure shall not alter the determined grading of the mixture on any sieve by more than +/- 3 percent.

Landscaping Close to Porous Asphalt Surfacing

20 Landscaping operations shall be carried out such that soil and other materials are not placed on the surface or cause any clogging of the porous asphalt. Porous asphalt shall be allowed to cool to ambient temperature before opening to any traffic. To avoid damage and to prevent detritus being spread over the surface, traffic and construction plant shall be kept off the surface after its completion and until opening of the road or until issue of the Certificate of Completion for the relevant Section of the Works, whichever is the later, unless otherwise agreed by the Employer's Representative.

939 Not Used

940 Relative Hydraulic Conductivity Test

Scope

1 This test determines the in situ relative hydraulic conductivity, at specific locations, of a permeable road surfacing. An estimate of the average value for the surfacing is obtained from the mean value of a number of determinations on each section of road.

Summary of Method

2 A radial-flow, falling-head, permeameter shall be used to determine the time taken for a specified amount of water, under known head conditions, to dissipate through an annular area of the surfacing. The reciprocal of the corrected outflow time shall be used to calculate the relative hydraulic conductivity of the surfacing.

Apparatus

3 The apparatus shall consist of:

i) Radial-flow falling head permeameter and standing board, constructed to the requirements and critical dimensions as described in DD229: 1996.

ii) Stopwatch, accurate to 0,1 s.

iii) Thermometer, with an accuracy of at least ± 1°C in the range 0 to 25°C.

iv) Clean water, in the range 0 to 25 °C.

Definitions

4 The outflow time shall be the time that elapses for an outflow of 2,0 litres through the permeameter, between the meniscus at the 2,5 litre mark and when it falls to the 0,5 litre mark. The series resistance time, r, shall be the outflow time(s), corrected to 20°C, when the outlet is not restricted by a surfacing. It shall be subtracted from measurements of outflow time when the permeameter is used on a surfacing. The parallel leakage time shall

be the outflow time when the outlet is restricted by an impermeable surface. The relative hydraulic conductivity (HC) is the reciprocal of the outflow time, after correction to 20°C, less the series resistance time.

Apparatus Constants and Calibration

5 The following checks shall be performed before using the equipment:

(i) Dimensions

All dimensions shall comply with those given in DD 229.1996.

(iii) Volume Calibration

Stand the permeameter on a flat and level surface. After inserting the plunger, fill the standpipe with 500 ± 0,25 ml of water, using a calibrated volumetric flask of 500 ml capacity. Mark the standpipe permanently at the meniscus level. Now fill the standpipe with a further 2000 ± 0,6ml of water, using a calibrated volumetric flask of 2000 ml capacity, and again mark the standpipe permanently at the new meniscus level.

(iii) Series Resistance Timer

Place the permeameter on blocks, of not less than 80 ± 5 mm height, to expose the 100 mm diameter aperture in the base. Fit the plunger in the orifice. Fill the standpipe completely with clean water. Measure and record the temperature of the water in the standpipe to the nearest 1°C. Remove the plunger and hang by its rest on the top of the standpipe. Start the stopwatch when the meniscus falls to the 2,5 litre mark. Stop the stopwatch when the meniscus falls to the 0,5 litre mark. Record the outflow time and repeat the measurement a further nine times. Calculate the average outflow time and correct to 20°C by dividing by the appropriate temperature correction factor from Table 9/31. Record the series resistance time, r, as the corrected average outflow time, to the nearest 0,1s.

(iv) Parallel Leakage Time

Place the permeameter on a flat and level impermeable surface. Fit the standing board on the base. Two operatives of approximately similar mass, within the range 75 ± 25 kg shall stand, one on each side of the standing board. Fit the plunger in the orifice. Fill the standpipe completely with clean water. Remove the plunger and hang by its rest on the top of the standpipe. Allow air bubbles to rise to the top and, if necessary, add more water to bring the water level above the 2,5 litre mark after all bubbles have ceased rising. Start the stopwatch when the meniscus falls to the 2,5 litre mark. Stop the stopwatch when the meniscus falls to the 0,51itre mark, or end the test if the outflow time exceeds 10 minutes. If the outflow time is less than 5 minutes, leakage is excessive and the permeameter is unsuitable for use for this test.

Procedure

6 The procedure shall be as flows:

i) Place the permeameter over the surfacing at the point where the relative hydraulic conductivity is to be measured. Fit the standing board on the base. Fit the plunger in the orifice. An operative shall stand on each side of the standing board, throughout the duration of the test, to hold the permeameter in place and compress the rubber annular disc to provide a seal.

ii) Fill the standpipe completely with clean water. Measure the temperature of the water in the standpipe and record it to the nearest 1°C.

iii) Remove the plunger and hang by its rest on the top of the standpipe. Allow air bubbles to rise up through the water in the standpipe until they no longer rise through the water, which is dissipating into the road surface.

iv) Replace the plunger and refill the standpipe to at least 50 mm above the 2,5 litre mark. Without delay, remove the plunger and hang by its rest on the top of the standpipe. Start the stopwatch when the meniscus falls to the 2,5 litre mark. Stop the stopwatch when the meniscus falls to the 0,5 litre mark. Record the outflow time, t1, to the nearest 0,1s.

v) Repeat step (iv) to obtain t2.

vi) Calculate the average outflow time and the range, both to the nearest 0,1s. If the range exceeds 5 per cent of the average outflow time, repeat step (iv) until the range criterion is met by two successive outflow times and discard other readings. Correct the average outflow time to 20°C by dividing by the appropriate temperature correction factor from Table 9/31 and record the corrected average outflow time, t, to the nearest 0,1s.

Table 9/31: Temperature Correction Factors

Temperature of water (°C)	Temperature Correction factor
0	1,79
1	1,73
2	1,67
3	1,62
4	1,57
5	1,52
6	1,47
7	1,43
8	1,39
9	1,34
10	1,31
11	1,27
12	1,24
13	1,20
14	1,17
15	1,14
16	1,11
17	1,08
18	1,06
19	1,03
20	1,00
21	,98
22	,96
23	,94
24	,91
25	,89

(i). The relative hydraulic conductivity (HC), corrected to 20°C is calculated from:

$HC = 1/(t-r)s^{-1}$

Where t is the average outflow time(s) corrected to 20°C;

r is the series resistance outflow time(s) corrected to 20°C

(ii). Report the relative hydraulic conductivity, corrected to 20°C, to the nearest $0,01s^{-1}$.

Measurement of the Average Relative Hydraulic Conductivity of a Section.

7 The procedure shall be as follows:

i) Measure the relative hydraulic conductivity as soon as possible after the surfacing has been laid and cooled to ambient temperature, but before the surfacing has been opened to traffic. The road shall be clean and free from loose material. Measurements can be made when the road is wet, but not if in a frozen state.

ii) Make individual determinations of the relative hydraulic conductivity in the nearside wheel path at 20m intervals along each carriageway lane.

iii) Calculate the running mean of each 5 consecutive measurements along each carriageway lane.

iv) Report the average relative hydraulic conductivity and the individual results, all corrected to 20°C, of each running mean of 5 individual determinations along each carriageway lane to the nearest $0,01s^{-1}$.

v) When an individual determination does not comply with the specified minimum requirement for relative hydraulic conductivity, further determinations shall be carried out at 5 m intervals in the wheel-path on either side of the non-complying location to determine the extent of the non-complying length. If the non-complying length exceeds 20 m, rectification shall be carried out by removing the full depth of the course and replacing it with fresh material laid and compacted in accordance with the Specification. The area rectified shall be the full width of the paving laid in one operation, and at least 30m long.

941 Modified Binder Storage Stability Test

Scope

1 This test determines the susceptibility of a preblended modified binder to separation or instability during prolonged storage at high temperature.

Summary of Method

2 A sample of modified binder shall be contained in a closed vessel of specific dimensions and shall be maintained at 160 ± 2°C for 7 days ± 2 hours. A binder sample shall then be taken from the top and bottom thirds of the vessel and both samples shall be tested for compliance with the binder specification.

Apparatus

3 The apparatus shall consist of:

(i) Cylinder, made of heat resistant glass, 190 ± 30mm long and 65 ± 5mm internal diameter having a removable lid, flush fitting to exclude air when the cylinder is filled with binder, and provided with three drain valves, one at the base, the other two spaced equally down the side of the cylinder, to allow the sample to be

divided into three equal portions as in sub-Clause 4 (vii) of the procedure.

Alternatively, a thin-wall sheet metal tube or similar vessel such as a 500 ml beverage can, of similar dimensions to the glass cylinder, and having a similarly removable lid, fitted either with or without drain-valves.

(ii) Oven, electrically heated, fan assisted, and capable of maintaining a temperature of 160 ± 2°C, having interior dimensions not less than 330mm from the top of the heating element to the top of the chamber and not less than 305mm in width and depth.

(iii) Tube holder, made of metal, that will hold either the glass cylinder or sheet metal can, in a vertical position, such that the base of the cylinder or can is not in direct contact with the oven floor.

(iv) Apparatus for determining the penetration and softening point of bitumen in accordance with IS EN 1426 and IS EN 1427.

(v) Transfer dishes (3), made of metal, each of a capacity sufficient to hold at least one third of the test sample.

Test Procedure

4 The procedure shall be as follows:

(i) The bulk sample of modified binder shall be obtained by sampling in accordance with IS EN 58.

(ii) Place the bulk sample of modified binder and the glass cylinder (or metal tube or equivalent vessel) in the preheated oven at 160 ± 2°C for a period not exceeding 3,75 ± 0,25 hours.

(iii) Remove the bulk sample from the oven and thoroughly mix by stirring to ensure obtaining a representative test sample.

(iv) Remove the glass cylinder (or metal tube or equivalent vessel) from the oven and completely fill with the modified binder test sample to allow no air space when the lid is fitted.

(v) Support the filled cylinder in a vertical position in the holder and transfer to the oven which shall be controlled at a temperature of 160 ± 2°C and allow to stand undisturbed for a period of 168 ± 2 hours.

(vi) If a vessel having drain-valves has been used for the test proceed using Method A below, otherwise proceed using Method B.

(vii) Method A

(a) Remove the glass cylinder (or alternative approved vessel) from the oven, keeping the cylinder vertical.
(b) Open the uppermost drain-valve and run off the top third portion of the test sample into a transfer dish for testing.
(c) Open the middle drain-valve and run off the middle third portion of the test sample into a suitable container and discard.
(d) Open the lower drain-valve and run off the bottom third portion of the test sample into a transfer dish for testing.

(viii) Method B

(a) Remove the tube or vessel containing the test sample from the oven and allow it to cool at room temperature for 2 ± 0,25 hours whilst maintaining the vessel vertical in the holder.
(b) When the vessel of modified binder has cooled to ambient temperature, remove it from the tube holder and make two cuts through the vessel and the sample at positions one-third and two-thirds of the length from, and parallel, to the base.
(c) Retain the top and bottom thirds of the test sample for further testing and discard the middle third.

(ix) Determine the penetrations and softening points of the top and bottom thirds of the test sample, in accordance with IS EN 1426 and IS EN 1427.

Reporting

5 For both the top and bottom thirds of the test sample the following shall be reported:

(i) The penetration, to IS EN 1426.
(ii) The softening point, to IS EN 1427.
(iii) Whether Method A or Method B was used.
(iv) The location and date of obtaining the bulk sample, and the dates of test.

942 Polymer Modified Stone Mastic Asphalt Surface Course

General

1 Polymer Modified Stone Mastic Asphalt (PMSMA) surface courses shall conform to IS EN 13108-5, the requirements specified in this clause and Appendix 7/1. They are here defined as an application of a polymer modified bitumen emulsion bond coat overlaid by a polymer modified hot bituminous mixture. This specification is for hot laid surfacings with a compacted thickness of 20mm to 40mm, in which the aggregate particles are necessarily gap-graded to form a stone to stone contact and to provide an open surface texture.

2 The mixture designation shall be one of the following;
(i) SMA 10 surf PMB 65/105-60 des
(ii) SMA 14 surf PMB 65/105-60 des

3 Evaluation of conformity shall be carried out in accordance with IS EN 13108-5.

Layer Thickness

4 The nominal thickness of the PMSMA surface course layer shall be in accordance with BS 594987 Table 6C.

Aggregate

5 The coarse aggregate shall consist of crushed rock complying with Clause 901.4 and the specific requirements of table 9/32.

6 The fine aggregate shall comply with the requirements of IS EN 13043 Part 2.

7 The fine aggregate shall be either a 0/2 mm or a 0/4 mm aggregate fraction and be of one of the following types:
a) crushed rock fines produced from coarse aggregate defined in IS EN 13043 or
b) sand; or
c) a mixture of a) and b).

Filler

8 The filler shall be crushed rock or limestone or hydrated lime or Portland cement as approved by the Employers Representative and not less than 75 percent shall pass the 0,063mm sieve. It shall conform to IS EN 13043.

Table 9/32: Coarse Aggregate Properties

Property	Category
Polished Stone Value	*PSV $60_{declared}$
Resistance to Fragmentation (Los Angeles Test)	LA_{25}
Aggregate Abrasion Value	AAV_{10}
Flakiness Index	FI_{15}

**Unless otherwise stated in Table 3.1 of HD36 (NRA DMRB 7.5.1).*

Binder

9 The binder shall be preblended polymer modified bitumen and shall comply with the selected requirements of IS EN 14023 as detailed in Table 9/33. The tolerance for the binder content in the mix shall be ± 0,3 percent of the target binder content given by the Contractor. The maximum Binder Drainage shall be $D_{0,3}$.

Bond Coat

10 Notwithstanding Clause 920, the following requirements shall apply. On all occasions that hot applied PMSMA surfacings are used the substrate should be sprayed with a polymer modified bitumen emulsion (PMBE). The rate of application of the bonding coat shall be such as to ensure that the residual bitumen coverage, after curing, in accordance with Table 3 and 4 of BS 594987. The bond coat and PMSMA surfacing shall be applied either by a paving machine fitted with spray bar i.e. integrated paver or alternatively the bond coat can be applied separately provided that after a reasonable time period (10 to 20 minutes) it is resistant to "pick up" on the wheels of rubber tyred vehicles and the footwear of operatives. In this case it shall provide a strong bond between the substrate and the hot-mixed thin surfacing when the latter is applied by a conventional paving machine. Fine aggregate dust shall never be used to prevent "pick up" as this will inhibit bonding between substrate and the PMSMA surfacing.

Additives

11 Inorganic or organic fibres may be used to assist in preventing binder draining from the aggregate. Adhesion agents or other additives may be added to the binder to improve the stripping resistance of the mixture. The suitability of such additives shall be

demonstrated in accordance with clause 4.1, IS EN 13108-5.

Mixture Requirements

12 The target composition of the mixture in terms of its constituent materials, the percentages passing the specified sieves, the binder type and binder content and the percentage and type of additive shall be declared and documented. The target aggregate grading and target binder content proposed by the Contractor shall be that which is required to satisfy the specific requirements of table 9/35. In addition compacted specimens at the target composition shall meet the wheel tracking requirements of Table 9/36 and shall have a Water Sensitivity value of $ITSR_{80}$. The method of laboratory compaction is by the Gyratory compaction method in accordance with IS EN 12697-31.The water sensitivity is expressed as the indirect tensile strength ratio (ITSR). The ITSR is calculated as the ratio of the indirect tensile strength of wet (water conditioned) specimens to that of dry specimens, expressed in percent. This test should be carried out in accordance with IS EN 12697-12 and at a test temperature of 25°C.

Mixing

13 The materials including any added filler shall be accurately weighed into a mechanical mixer and thoroughly mixed in such a manner that all particles are completely coated. The Contractor shall supply a service certificate showing that all weighing devices have been calibrated in accordance with the quality plan and audited to ISO 9001, within six months prior to the Contract Date.

Laying

14 PMSMA surface course materials shall not be laid during heavy and/or persistent rain or when standing water is present. It shall be laid within the limits of air temperature and wind speed stated in Figure 9/3. The range of delivery and rolling temperatures shall be as stated in Table 9/34. Prior to laying operations the Contractor shall carry out any necessary remedial repairs. The type and extent of such repairs shall be agreed with the Employers Representative. Where necessary, existing surfaces shall be regulated in accordance with the requirements of Clause 907, in advance of laying surfacing material to this clause.

Performance Requirements

15 The Contractor shall guarantee the performance, surfacing materials and workmanship for a period of three years from the date of opening the surfacing to traffic or for such longer period as specified in Appendix 7/1. In the event of failure of the surface to meet the performance specification for the guarantee period, the Contractor shall replace the material in accordance with this specification and in accordance clause 702.10. The requirements for Texture Depth - initial and after three years in service shall be as stated in Table 9/37. The texture depth of the surfacing after compaction and before opening to traffic shall be measured in accordance with Clause 921 of this series and shall conform to the requirements of Table 9/37.

Surface texture measurements made after periods in service shall be made in the nearside wheel track at 5 metre intervals in a longitudinal direction. These shall be carried out on both sides of the carriageway, i.e. in both traffic directions. After three years in service visual assessment shall show no loss of the surfacing material due to attrition or debonding or ravelling or surface disintegration or cracking. The guarantee shall exclude defects arising from damage caused by settlement, subsidence or failure of the carriageway on which the material has been laid.

Figure 9/3 Limiting weather conditions for laying PMSMA surface materials

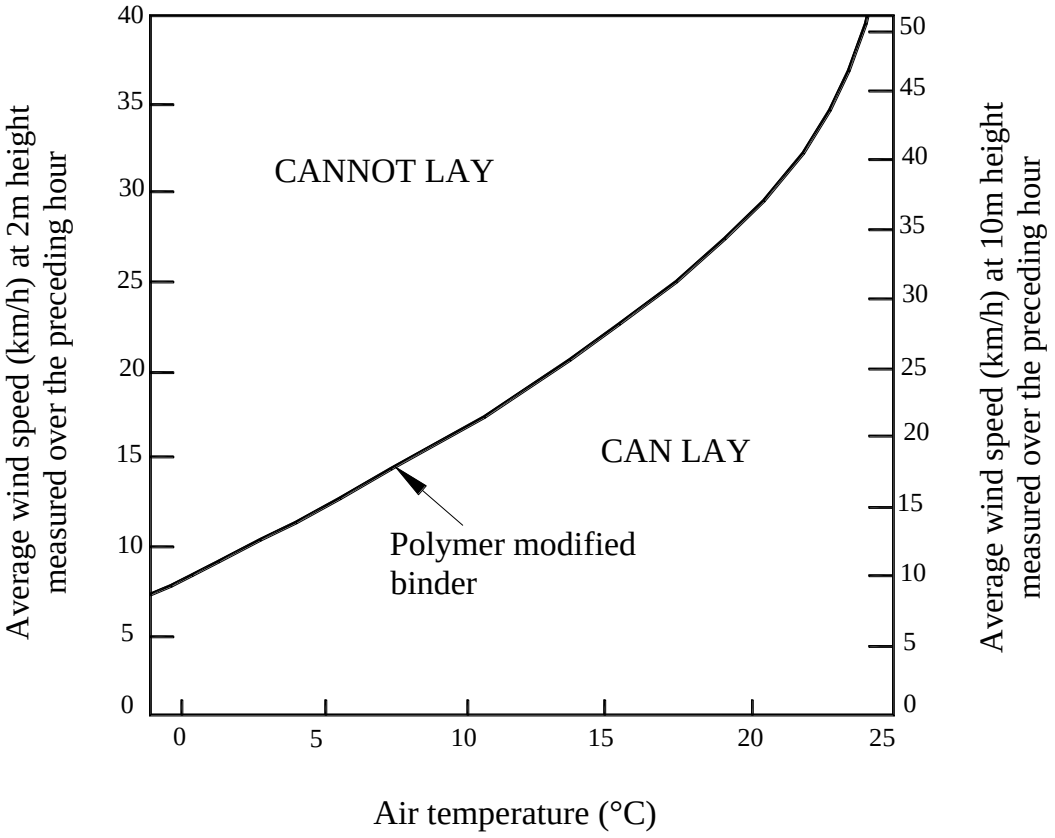


Table 9/33 : Properties of PMSMA Surface Course Polymer Modified Binder

Properties	Test Method	Specified Value
Penetration at 25°C 0,1mm	IS EN 1426	65-105
Softening point, °C	IS EN 1427	>60
Fraass Brittle Point	IS EN 12593	<-12
Storage Stability, °C difference in softening point, top – bottom, after four days at 160°C	Clause 941	<5
Resistance to Hardening (Rolling Thin-film Test) Mass Change, (Percent) Retained Penetration (Percent) Softening Point Increase °C Softening Point Decrease °C	IS EN 12607 – Part1	<1,0 >60 <8 <2

Table 9/34: Mixing and Handling Temperatures

Binder Type	Mixing Temperature Range (°C)	Delivery Temperature Range (°C)	Minimum Temperature (°C) Compacting	
			Start	Finish
Polymer modified	In accordance with manufacturers' requirements	145 - 170	140	115

Table 9/35: Target limits for composition for PMSMA surface course

Mix Designation	SMA 10	SMA 14
Test sieve (mm)	Passing sieve (% by mass)	
31,5	-	-
20	-	100
14	100	90 – 100
10	90 - 100	35 – 60
6,3	30 - 55	20 – 45
4	-	-
2	20 - 35	15 – 30
0,063	6 - 12	6 – 12
Minimum Target Binder Content (% by mass of total mixture) B_{act}		
Polymer Modified Bitumen	5,3	5,3

Table 9/36: Wheel Tracking requirements for site classifications

Classification		Test temperature	Category WTS_{AIR}	Category PRD_{AIR}	Requirements when tested to BS 598-110	
		Test method	IS EN 12697-22, Small device, Procedure B	IS EN 12697-22, Small device, Procedure B		
No.	Description	°C	Wheel track slope µm/cycle	Proportional rut depth (mm)	Max rut rate (mm/hr)	Max rut depth (mm)
1	Moderate to heavily stressed sites requiring high rut resistance	45	$WTS_{AIR\ DECLARED}$	$PRD_{AIR\ DECLARED}$	2	4
2	Very heavily stressed sites requiring very high rut resistance	60	$WTS_{AIR\ DECLARED}$	$PRD_{AIR\ DECLARED}$	5	7
3	Other sites	N/A	$WTS_{AIR\ NR}$	$PRD_{AIR\ NR}$	-	-

Notes:
1 The values for WTS_{AIR} and PRD_{AIR} categories above shall be declared until experience with the test methods has been established. It is therefore recommended that the test method described in BS 598-110 be used in conjunction with the EN method, and that the results be correlated with results obtained on the same mixtures.
2 The values given in SR28 Table 36 for the BS 598-110 method should be used until an acceptable correlation has been established.

Table 9/37: Requirements for texture depth

Road Type	Nominal stone size of mix, mm	Initial, after laying		After 3 years	
		Average for each lane km or surfaced length if less than 1 Km	**Average for a set of 10 measurements, mm**	**Average for each lane km or surfaced length if less than 1 Km**	Average for a set of 10 measurements, mm
Mandatory speed of traffic >60km/h	10	≥1,5mm	≥1,2mm	≥1,3mm	≥1,0mm
	14	≥1,5mm	≥1,2mm	≥1,3mm	≥1,0mm
Mandatory speed of traffic ≤60km/h and roundabouts	10	≥1,2mm	≥1,0mm	≥1,0mm	
	14	≥1,2mm	≥1,0mm	≥1,0mm	

943 Hot Rolled Asphalt Surface Course and Binder Course (Performance-Related Design Mixtures)

1 Hot Rolled Asphalt performance related design surface course and binder course shall conform to IS EN 13108-4, the requirements of this Clause and those specified in Appendix 7/1.

2 Performance related surface course mixtures shall be 35/14F and 30/14F. Target composition requirements are provided in Clause 910 of this Series.

3 Evaluation of conformity shall be carried out in accordance with IS EN 13108-4.

Layer Thickness

4 The nominal thickness of the Hot Rolled Asphalt surface course layer shall be either 45mm or 50mm unless otherwise specified in Appendix 7/1.

Binder and Binder Modification

5 For performance based materials, either a paving grade bitumen or a polymer modified bitumen to IS EN 14023 or a blend of one of these with natural bitumen in accordance with Annex B, IS EN 13108-4 may be used. The Contractor shall provide data sheets giving details of the properties of modified binders, whether the modifier is preblended with bitumen, the bitumen is modified during refinery processing or modified by addition into the asphalt mixer, including those specified in Appendix 7/1. These shall include rheological data in accordance with Clause 928 and cohesion in accordance with Clause 939. Polymer modified binders, modified binders or additives shall not be used without the approval of National Roads Authority; unless already specified within the Clauses of this Series.

Binder Volume

6 The minimum binder volume determined in accordance with clause 5.2.4, IS EN 13108-4, and the trial strip protocol in Annex F, BS 594987 shall be category $B_{vol\ 15,5}$.

Aggregate

7 The coarse aggregate shall consist of crushed rock complying with Clause 901.4.

8 The fine aggregate shall comply with the requirements of IS EN 13043 Part 2.

9 The fine aggregate shall be either a 0/2 mm or a 0/4 mm aggregate fraction and be of one of the following types:

a) crushed rock fines produced from coarse aggregate defined in IS EN 13043 or
b) sand; or
c) a mixture of a) and b).

Added Filler

10 Added filler shall consist of crushed rock, crushed slag, hydrated lime, cement (CEM I or CEM II complying with IS EN 197-1) or other material approved by the specifier.

11 The loose bulk density in kerosene of added filler, with the exception of hydrated lime, shall be in accordance with clause 5.5.5 of IS EN 13043.

Additives

12 Additives permitted for inclusion may include: fibres, pigments and adhesion agents. The

suitability of such additives shall be demonstrated in accordance with clause 901.2 and IS EN 13108-4.

Void Content

13 The void content of the mixture at target composition determined in accordance with the trial strip protocol in Annex F, BS 594987 shall be as follows:

- The average void content category of core pairs shall be $V_{max7,5}$.
- The average void content category of the set of six cores shall be V_{max5}.

Deformation Resistance

14 The resistance to permanent deformation of the mixture shall be determined in accordance with IS EN 12697-22 and shall meet the following requirements for the appropriate class as specified in Appendix 7/1.

15 The resistance to permanent deformation shall comply with Table 9/38. Tests can be carried out on specimens at the target composition using the small wheel tracking device on 305 mm square slabs which are compacted by a laboratory roller compactor in accordance with IS EN 12697-33. Alternatively, 200 mm diameter core specimens can be taken from a full scale trial strip in accordance with the trial strip protocol in Annex F, BS 594987.

16 When specified in Appendix 7/1, the resistance to permanent deformation of material laid in the Works shall be monitored by testing in accordance with clause F.3 of BS 594987 Annex F. Six cores shall be taken from the first kilometre length of material from each mixing plant and thereafter one further core from each subsequent lane kilometre. Results shall be assessed on successive rolling means of sets of six consecutive results and shall be deemed to conform if the mean is no greater than the specified value and individual values not more than 50% greater than the specified value.

Coated Chippings for Surface Course

17 When required, coated chippings shall be 14/20mm as specified in Appendix 7/1 and comply with Clause 915.

Surface Macrotexture for Surface Course

18 The surface macrotexture shall comply with Clause 921.

Compaction Control Procedures

19 Control testing for compaction and resistance to permanent deformation shall be carried out in accordance with BS 594987 section 9.5.2.

944 Not Used

Table 9/38 — Limiting wheel tracking recommendations for Performance Related HRA

Classification		Test temperature	Category WTS_{Aair}	Category PDR_{Aair}	Requirements when tested to BS 598-110	
		Test method	IS EN 12697-22, Small device, Procedure A	IS EN 12697-22, Small device, Procedure A		
No.	Description	°C	Wheel track rate µm/cycle	Maximum rut depth (mm)	Max rut rate (mm/hr)	Max rut depth (mm)
1	Moderate to heavily stressed sites requiring high rut resistance	45	$WTS_{Aair\ Declared}$	$PRD_{Aair\ Declared}$	2	4
2	Very heavily stressed sites requiring very high rut resistance	60	$WTS_{Aair\ Declared}$	$PRD_{Aair\ Declared}$	5	7
3	Other sites	N/A	$WTS_{Aair\ NR}$	$PRD_{Aair\ NR}$	-	-

Notes:
1 Guidance on Site Classifications relating to design requirements for Performance-related Hot Rolled Asphalt surface course is given in BS 594987.
2 The values for WTS_{Aair} and PRD_{Aair} categories in Table 9/38 — Limiting wheel tracking recommendations shall be declared until experience with the test methods has been established in Ireland. It is therefore recommended that the test method described in BS 598-110 be used in conjunction with the EN method, and that the results be correlated with results obtained on the same mixtures. The values given in Table 9/38 for the British Standard method should be used until an acceptable correlation has been established.

945 Weather Conditions for Laying of Hot Bituminous Mixtures

1 The Contractor shall take account of the weather conditions when planning his working methods. The Contractor's working methods shall comply with all weather-related requirements of BS 594987 and any additional requirements of this clause. When laying is to be undertaken during winter (October to April) and/or night time (9 p.m. to 6 a.m.), the Contractor shall work to a Quality Plan that allows for the specific issues raised by winter and/or night time working.

2 Hot bituminous materials laid less than 50mm thick, other than those supplied to Clause 942 and 938, shall be laid within the wind speed and temperature constraints of Figure 9/4. Laying of road pavement materials containing bitumen binders may proceed provided the temperature of the surface to be covered is 2°C or more, the air temperature is at or above 0°C and rising and the surface to be covered is dry, unfrozen and free from ice. snow, salt and grit. Additional overriding constraints on wind speed and temperature during laying for specific materials are identified in sub-clauses 3, 4 and 5 below.

Porous Asphalt and Polymer Modified Stone Mastic Asphalt Surface Courses

3 The weather conditions for laying Porous Asphalt and Polymer Modified Stone Mastic Asphalt Surface Courses shall comply with those identified as being acceptable in Clauses 938.14 and 942.12 respectively together with the associated Quality Plan and Installation Method Statement.

Hot Rolled Asphalt with pre-coated chippings

4 Hot Rolled Asphalt surface course mixtures incorporating 35% coarse aggregate with pre-coated chippings shall be laid 50mm thick, within the following constraints of delivery temperature, wind speed and air temperature.

Air temperature (minimum): 0 °C

Wind speed
(maximum at any air temperature): 40km/h
(at 2m height), or
Minimum delivery
temperature of materials: 155°C.

When an anemometer is not available, with approval of the Employer's Representative, hot rolled asphalt wearing course materials incorporating 30% coarse aggregate shall have a minimum delivery temperature of 165°C and shall be laid 50 mm thick. It shall not be laid when the air temperature falls below 5°C unless the temperature of the surface to be covered is 3°C or more.

Wind Speed

5 When measurements are required for assessment, wind speed shall be measured by anemometer positioned near the laying site to accurately reflect conditions at the laying site. The anemometer shall be fitted with a digital accumulative device.

Figure 9/4: Wind Speed and Air temperature Laying restrictions for Layers less than 50mm thick